ASTM Bulletin

Committee Week, Pittsburgh, Pa.
February 2-6, 1959

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ASTM BULLETIN

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TECHNICAL PAPERS

RESEARCH AND STANDARDS IN ACTION

DEPARTMENTS

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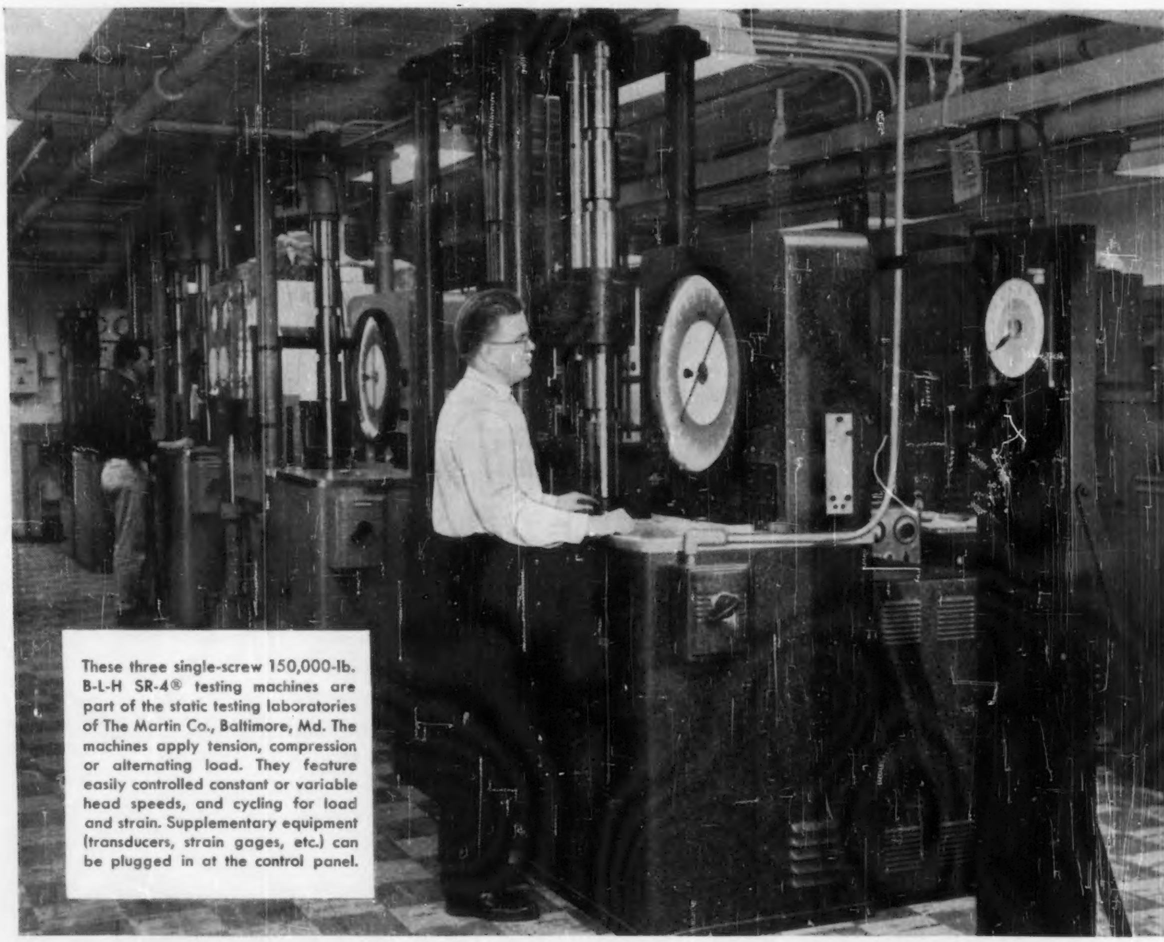

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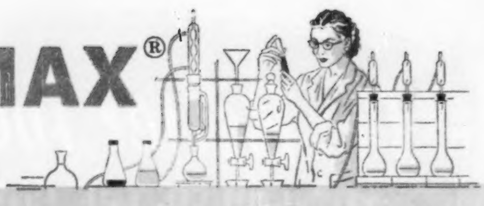

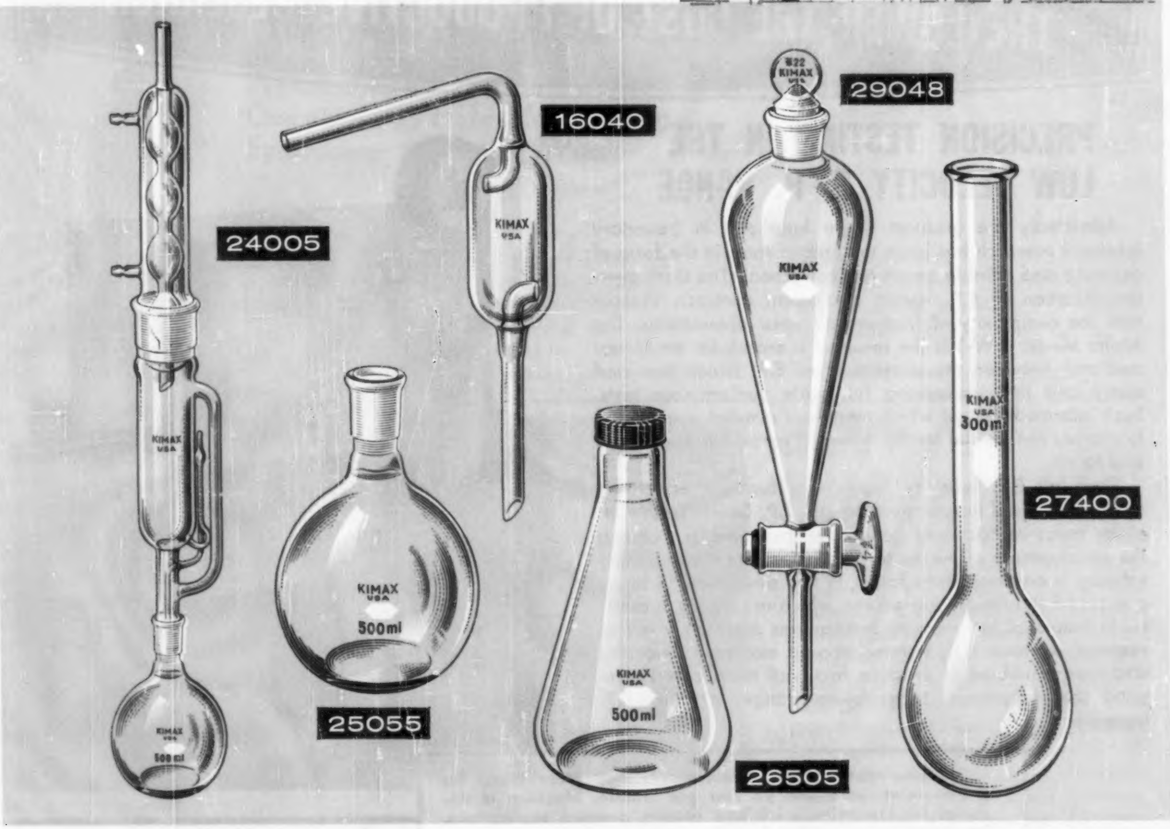

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Pittsburgh to Be Host to 1959 ASTM Committee Week

Technical Consultant on Atomic Energy to Speak
Committees to Hold 350 Meetings
Symposium on Testing Windows

JOHN C. WARNER, President, Carnegie Institute of Technology and Technical Consultant to the U. S. delegation to the Second U. N. International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland, will be the guest of honor and speaker at the Committee Week dinner on Wednesday, February 4.

On Tuesday noon, February 3, an Industry Luncheon is being planned with the subject to be announced.

Approximately 1500 to 2000 ASTM members, committee members, and visitors will meet at Pittsburgh in the Penn Sheraton Hotel the week of February 2 to 6 for the Society's 1959 Committee Week meeting. About 30 of the Society's main technical committees will hold some 350 meetings of subcommittees and working groups to advance toward completion the year's work in anticipation of preparing reports for presentation to the Society at the Annual Meeting in June.

The Pittsburgh District Council under the chairmanhsip of J. R. Romualdi, assistant professor of civil engineering at Carnegie Institute of Technology, with the assistance of Vice-Chairman E. J. Holcomb, Aluminum Company of America, and Secretary A. S. Orr, Gulf Oil Corp., is planning the Committee Week dinner and the social hour preceding it.

Messrs. M. D. Baker, West Penn Power Co. and C. H. Sawyer, Eastern Gas and Fuel Associates, are serving as the Finance Committee.

(Continued on next page)

John C. Warner, physical chemist and educator, was granted leave from Carnegie Institute of Technology during World War II to supervise research on the chemistry and metallurgy of plutonium. He has served as a member of the Executive Board of the Council of Participating Universities, Argonne National Laboratory, Lemont, Ill., and as a member of the General Advisory Committee to the U. S. Atomic Energy Commission. In 1958, he attended the Second U. N. International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, as a technical consultant to the U. S. delegation.

Dr. Warner has been president of Carnegie Institute of Technology since 1950. His administration has established the Graduate School of Industrial Administration, Department of Biological Sciences, Nuclear Research Laboratory, and Chemical and Petroleum Research Laboratory. He is the coauthor of several textbooks on chemistry and has written numerous papers on physical chemistry and on education in science.

These committees are scheduled to meet in Pittsburgh . .

As this issue of the BULLETIN goes to press, the committees listed below have indicated their intention to meet in Pittsburgh. The *official call* for the meeting will come from the officers of the committees themselves.

- **A-3** on Cast Iron
- **A-5** on Corrosion of Iron and Steel
- **A-6** on Magnetic Properties
- **A-7** on Malleable-Iron Castings
- **A-10** on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys
- **B-6** on Die-Cast Metals and Alloys
- **B-7** on Light Metals and Alloys, Cast and Wrought
- **B-8** on Electrodeposited Metallic Coatings
- **B-9** on Metal Powders and Metal Powder Products
- **C-3** on Chemical Resistant Mortars
- **C-7** on Lime
- **C-8** on Refractories
- **C-11** on Gypsum
- **C-12** on Mortars for Unit Masonry
- **C-15** on Manufactured Masonry Units
- **C-16** on Thermal Insulating Materials
- **C-22** on Porcelain Enamel
- **D-3** on Gaseous Fuels (Subcommittees only)
- **D-4** on Road and Paving Materials
- **D-5** on Coal and Coke
- **D-8** on Bituminous Materials for Roofing, Water-proofing and Related Building or Industrial Uses
- **D-11** on Rubber and Rubber-Like Materials
- **D-24** on Carbon Black
- **D-25** on Casein and Similar Protein Materials
- **D-26** on Halogenated Organic Solvents
- **E-1** on Methods of Testing (Subcommittees only)
- **E-4** on Metallography
- **E-5** on First Tests of Materials and Construction
- **E-6** on Methods of Testing Building Constructions
- **E-7** on Nondestructive Testing
- **E-9** on Fatigue
- **E-10** on Radioisotopes and Radiation Effects

Symposium on Window Testing

In addition to the committee activities, there will be a Symposium on Window Testing sponsored by Committee E-6 on Methods of Testing Building Constructions. The tentative list of papers to be presented follows:

Considerations in Evaluating Factory Sealed Double Windows—A. Grant Wilson and K. R. Solvason, National Research Council of Canada.

Practical Test Experience with Certain Aspects of Glass Performance—C. R. Frownfelter, Pittsburgh Plate Glass Co.

Structural Aspects and Operations of Windows—E. M. Lurie, Veterans Administration.

Norwegian Test Methods for Rain Penetration Through Windows—Norwegian Building Research Institute.

Need for Research and the Development of Test Methods for Windows—L. M. Dunn, Aluminum Company of America.

This symposium is being arranged under the chairmanship of R. B. Crepps of Purdue University, chairman of Subcommittee VIII. It is being developed to fill an indicated need for information of this kind for use by the construction industry.

Mellon Square, Pittsburgh, showing, on the left, the Alcoa Building and, on the right, the Penn-Sheraton Hotel, headquarters for ASTM Committee Week, February 2 to 6, 1959.

Third Pacific Area National Meeting

San Francisco will again be host to the American Society for Testing Materials on October 11–16, 1959, when the Third Pacific Area National Meeting and Apparatus Exhibit will be held at the Sheraton-Palace Hotel. Members will recall that the first Pacific Area National Meeting of the Society was held in San Francisco in 1949, more or less as an experiment to explore the possibility of holding a national meeting in the growing industrial community of the western states. The success of the initial meeting was followed by an outstanding second meeting in Los Angeles in the fall of 1956 with the largest technical program ever attempted by the Society.

The General Committee on Arrangements (Bulletin, May 1958, p. 14) headed by Paul V. Garin, ASTM past director and engineer of research and mechanical standards, Southern Pacific Co., is working vigorously toward making the coming meeting even more outstanding. Invitations have been sent to the chairmen and secretaries of all ASTM technical committees to consider San Francisco as the site of their fall meetings. In addition to the anticipated 150 to 200 committee and subcommittee meetings, there will be some 40 to 50 technical sessions. The current list of symposia planned include the following:

- **New Metals**
- **Effect of Water-Reducers and Retarders on Properties of Concrete**
- **Masonry Materials**
- **Durability and Weathering of Structural Sandwich Construction**
- **Ceramics in Nuclear Energy**
- **Paints**
- **Hydraulic Fluids**
- **Road and Paving Materials**
- **Wood**
- **Bituminous Waterproofing and Roofing Materials**
- **Electrical Insulating Materials**
- **Adhesives**
- **Soils for Engineering Purposes**
- **Technical Development in the Handling and Utilization of Water and Industrial Waste Water**
- **Reinforced Plastics**
- **Optical Emission, X-Ray Fluorescence, Flame Photometry, Infrared Absorption, Ultraviolet Absorption, and Magnetic Resonance Spectroscopy**
- **Nondestructive Testing**
- **Fatigue of Aircraft Structures**
- **Radiation Effects and Dosimetry**
- **Applied Radiation and Radioisotopes**
- **Standards and Research of Materials**
- **Atmospheric Sampling for Smog Control**

Following the success of the exhibit in Los Angeles, another "extra" exhibit will be held. While this is being arranged especially for the benefit of western members and manufacturing companies who do not ordinarily participate in the exhibits held in the east, many of the Society's regular exhibitors will have displays of the latest developments in testing and scientific apparatus, laboratory supplies, and related materials.

1959 will be an outstanding year for the Society with its three major meetings: Committee Week, February 2–6; the Annual Meeting, June 21–26; and the 3rd Pacific Area National Meeting, October 11–16. Members are urged to plan now to attend the San Francisco meeting and to combine their travel with their vacation plans. The General Committee on Arrangements will have an interesting entertainment program for ladies.

Inventions

Science and

Research

in the Highway Program

By JOHN A. VOLPE

Mr. Volpe, president, John A. Volpe Construction Co., Malden, Mass., served as the first Federal Highway Administrator. In this address, presented at the "Road Materials" Industry Luncheon at the ASTM Sixty-First Annual Meeting in Boston, Mass., he characterizes the new Federal highway program as "one of the greatest economic influences of this century." He commends the Society on its outstanding contributions of research and standardization in this field and mentions a number of areas where more work is needed. This address is a graphic presentation of what is involved in this tremendous road building program—by a man of unique qualifications.—*Editor*

As EXECUTIVES of the nation's firms and organizations which will do the testing and set the standards for the materials to be used in the federal highway aid program now swinging into high gear, you have the great responsibility of seeing that no shoddy, slipshod materials are used in this highway program—your committees have developed the standards for the materials used directly in this road and paving work.

I need not dwell at any great length on the need for such a vast undertaking. Suffice it to say that we now drive six times as many motor vehicles more than ten times as far, and much more than twice as fast as today's roads were designed to carry.

The present inadequate highway system, which is not much better than it was in 1931, has seen an increase in the number, size, weight, and capacity of trucks alone which has been overwhelming. In 1957, interstate trucks alone moved some 240 billion ton-miles of freight which was 12 times the amount carried in 1931. Yet, in the twenty-six-year period, we added very little mileage to the road system.

Years ago the safe capacity of our highways was exceeded, and you know the results of our failure to keep pace with motor vehicle use by new highway construction.

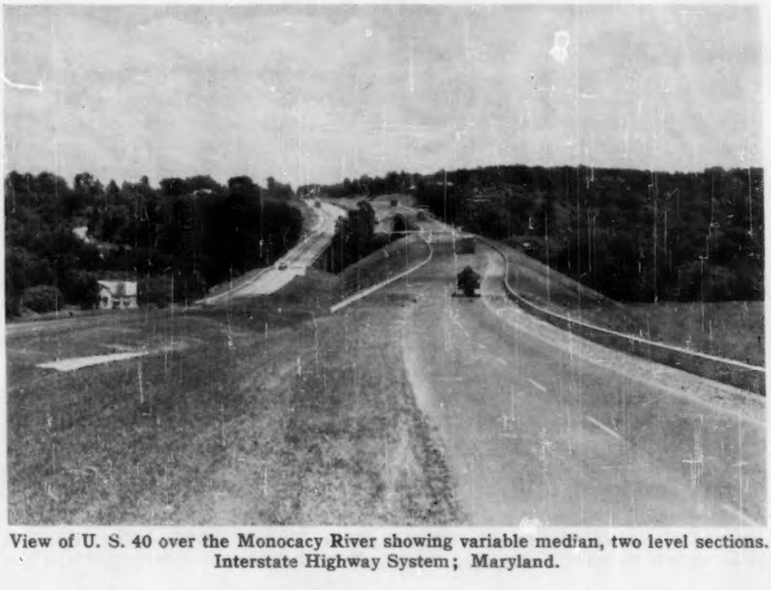
You know the intolerable conditions that existed—an accident toll that amounted to slaughter, and caused more fatalities than were totalled in all our wars from Bunker Hill through Korea. You know the traffic tieups, the delays, and the frustration, not only in the cities but in the country as well, as America sought vainly to escape it.

The Federal Highway Act

So when President Eisenhower, in 1954, made his bold and dramatic move to break the log jam and do something on a colossal scale to solve this critical problem, we in the construction industry and its affiliates joined with the nation in applauding him.

And it is to the eternal credit of the two major parties, that the congress, by bipartisan action, not only followed the President's leadership by passing the 1956 Federal Highway Act, but also broadened its scope this year to make more funds available, and thus assure probable completion within the thirteen-year-period originally set.

It was to be expected that there would be some criticism of the method of administration throughout the forty-



View of U. S. 40 over the Monocacy River showing variable median, two level sections. Interstate Highway System; Maryland.

Mobile, electronic traffic analyzer developed by the Bureau of Public Roads and used to conduct research on driver behavior and highway capacity.

eight states, particularly with the mileage allocations for the new highway system.

Allocation is by a formula, which is somewhat complicated, and which embraces a number of factors. As former federal highway administrator, and a former Massachusetts public works commissioner, I give you unhesitatingly my assurance, and I keep in touch with the situation, that the program is moving with dispatch, that adequate safeguards and standards cover it and that no one is being discriminated against in the matter of allocation.

The job is gigantic—its magnitude unprecedented in world history—and I include the days of Ancient Rome and its tremendous building of the radial highway system by slave labor. For those who have been privileged to travel over the Appian Way, reflect on it for a moment. It is really awe-inspiring. They really built for posterity in those days, and I think it could well be a challenge for all of us here, for if with all of our modern-day know how we could build roads that will withstand time and travel as has the old Appian Way, we would truly accomplish a feat.

To build 41,000 miles of superhighway with hundreds of thousands of causeways, trumpet exchanges, bridges, or cloverleafs and grading; draining, leveling, paving, lighting, shouldering, landscaping, and fencing an area somewhat bigger than the state of Rhode Island; and to do it all on schedule, is, I submit, truly a task that calls for all the modern skills known to man.

Can we do it, and on schedule? I have every confidence that we can and will, barring unforeseen contingencies. Now remember that this is only for the new system of interstate and defense highways, which will connect 90 per cent of the Nation's larger cities with a population of over 50,000, and which will permit you to cross the country from Boston to the Pacific coast without once stopping for a traffic light or grade crossing.

It does not take into consideration the continuing construction program on arterial and belt routes in the cities, eliminating bottlenecks and extending the secondary, suburban, and farm-to-market roads.

New Methods Make Plan Possible

Can we do it all? I am sure we can, what with the development of modern engineering sciences. I am sure it never could have been done years ago when we built today's roads using horse and dumpcart methods.

In those days the bushwhackers trudged cross country on foot, skirting hills and dodging streams and other natural obstructions. Following were the surveyors and the man walking with the chain to measure.

How different today—the bushwhacker and his mates are supplanted by a flying scientist equipped with a $17,500 camera that takes pictures every $3\frac{1}{2}$ sec from a height of 2400 ft as the plane travels 300 mph. Not one, single picture, but two of each area from different angles, to give three-dimensional view.

Then we have the machine known as the "plotter" which stereoscopically superimposes these two pictures taken 1440 ft apart from the highway engineer, and it is claimed that a skillful operator can tell from these sky shots even the depth and gallon content of a body of water.

He can then make the machine sketch a contour map that fits the earth and shows with uncanny accuracy the precise location and size of every tree, boulder, gully, and bush.

The transit men and surveyors with their measuring chains have been supplanted by a geodimeter, and now even that has been displaced by the South African built "tellurometer," which is quicker and more portable

What a wonderful age. The tellurometer aims a microwave at another similar device located 40 miles away on some prominent feature of the landscape and records how many thousand millionths of a second is required for the wave to hit target and return. Then when the altitudes of the two machines are correlated, the machine will translate at once the distance between machines in miles, yards, feet, and inches.

The principal criticism of the new highway program to date is that it takes a long time from decision to build roads for which finances are available to the turning of the first shovel of earth.

The magnitude of the engineering job involved is tremendous. As an example, the book of plans for one eight-mile stretch of the New York State superhighway has 1200 maps alone, together with thousands of pages of specifications. That is for just eight miles. Project that into the program of building 41,000 miles. Designing some complicated highway structures requires up to 36,000 computations—say a single bridge. Multiply that by the vast numbers of designs for the 41,000 miles and you have a problem in arithmetic which is just impossible to grasp—under old methods.

Computers Speed Calculations

Fortunately, science has again come to our aid in the matter of computation. You take all your known facts and figures. You add the information from tellurometer and from newer types of mechanical and automatic survey, such as radar and cans by the roadside, electric eyes from the berm, and pressure pad counters built right into the surface.

All of these, together with your origin and destination surveys, and your traffic counts, are fed into one of those fabulous digital electronic computers, like Univac or I.B.M. Despite their

stratospheric cost, you just couldn't do the job without them. Some 27 state highway departments now have them and 11 others have ordered the so-called "human-brain" machines.

On one survey made in Massachusetts for the federal interstate program, it took the electronic computer only two days to come up with answers that would have taken ten years time of a man with an ordinary desk calculator. It is reported that a computer program in Georgia produces geometric calculation for skewed bridges in ten minutes, against the probably one week it took with old time methods.

Consider the bewildering factors involved. Your traffic counts and surveys have shown where the road should be built. So your design engineer draws a straight line on that aerial map we spoke of. Now, some of the matters to be considered and evaluated are what route or routes require the least valuable land, the shortest distance, the drainage problem solution, minimum earth moving, the impact on the neighborhood and the community, uprooting of homes and people, minimum damage to the area, greatest service to the public, and lowest cost.

Before even starting preliminary design, the engineer must resolve cutting through or going around a hill, curves, and grades to speed or slow tomorrow's traffic, angles of the sun hitting the road and a host of other considerations.

Safety is a primary objective. Our leaders hope and expect to cut the accident toll and to give you a scenic, unmarred highway over which you may easily, restfully, confidently, and safely travel at a speed consistent with conditions.

One of the greatest advantages of the computers is that instead of getting a single highway route decision, you can get alternative routes with little or no more time or trouble. Then when it does become necessary—as it will—to make changes and compromises, you are months ahead in shifting to an alternate which has already been worked out, instead of doing that work all over again.

Nationally, figures show, it has been taking upward of 54 months on an average to build a superhighway. That is 30 months plus, for preliminaries, 24 months actual construction time. Officials in Ohio estimate they cut about 60 per cent from the time for the preliminaries, using today's computing equipment.

And as we harness more and more of the new scientific equipment it seems fair to assume that more and more time will be cut from the studies as the program continues its progress.

ASTM Plays a Vital Part

But these scientific computations and machinery would be to no avail without the work of the American Society for Testing Materials, and your technical committees.

We all know that the work of your technical committees many of which were organized in the early nineteen hundreds, is responsible for and has developed test methods and specifications that give us suitable surfacing for the modern cars, trucks, and equipment to operate on safely today.

Because of your background of technical knowledge and accomplishments, as well as your familiarity with current trends you, and your committees can be instrumental in accelerating the present highway program by continuing to sponsor research designed to improve the quality of materials, methods of measuring the physical and chemical properties of materials, and to reduce the time and manpower required for materials inspection and control.

For instance, take the use of blast-furnace slag as a component of cement, which reduces the cost of the product and adds to the durability of the concrete. And your studies of admixtures, which will make concrete more plastic and more readily placed, especially in hot weather. While it is true that these particular admixtures are marketed primarily as retarders, your extensive investigations now in progress may show other beneficial effects.

The use of fly ash as a plasticizer (and also, in times of shortage of portland cement, to augment the supply) improves the quality of cements as to strength, resistance to weathering, and the action of alkalies and reduction in volume changes.

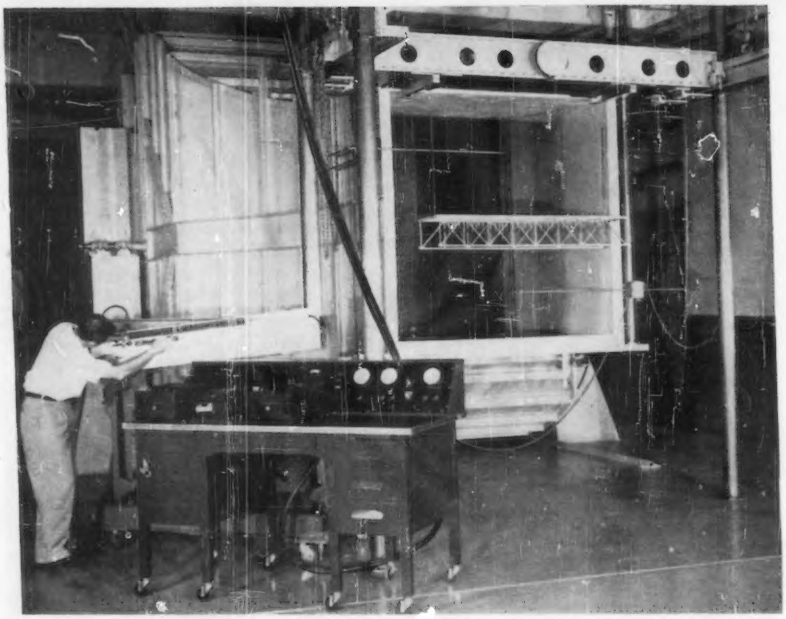
Slipperiness of both portland-cement concrete and bituminous road surfaces has become a major problem in some areas. And Boston is one of those areas. What an important task confronts you. There have been indications that in selecting natural aggregates for skid resistance there may be a tendency to compromise such qualities as hardness or toughness in order to avoid aggregates that polish under traffic. Any such trend must be discouraged to the greatest possible extent, but the problem of developing skid-resistant roads is a serious one.

New Standards and Research Needed

Special test and procedures are needed for close control of the quality and uniformity of portland-cement concrete for pavements, prestressed bridge and other structural members. Nondestructive tests such as the use of supersonic impulses and the swiss hammer seem especially well suited for checking hardened concrete. Tests can be made very rapidly with these devices.

Now let us for a moment think of the scarcity or virtual lack of tests indicative of the quality of bituminous materials. Research designed to remedy this situa-

The Schuylkill Expressway (City Line Ave. Interchange) in Philadelphia, Pa. This 20-mile expressway, a part of the Interstate Highway System, joins the Pennsylvania Turnpike near Valley Forge with the downtown area of Philadelphia.



Testing a section model of a suspension bridge in a wind tunnel in the laboratories of the Bureau of Public Roads.

tion is under way and new efforts to develop quality tests and to raise quality standards for asphalt are being planned cooperatively by representatives of consumer and producer interests. In this connection, there is renewed interest in determining the composition of asphalt with the purpose of isolating the component parts that control the important engineering properties of the material, such as its ability to resist deterioration during mixing, and subsequent weathering, and its adhesion to the aggregate. It is felt that this type of research may lead to the practice of producing "tailor-made" asphalts having essentially the exact qualities needed for specific purposes.

Other new techniques for the rapid determination of fundamental properties of asphalt, such as absolute viscosity and changes in this property resulting from heating in thin films, as in mixing plant operations, are claiming considerable attention.

Blending of asphalts to desired grade by means of automatic proportioning equipment at the tank car or truck, rather than in the processing plant, is a relatively new development that may permit important economies in plant facilities, storage tank requirements and time. Early indications are that the uniformity of the blends is satisfactory.

Studies of mixtures of asphalt and aggregate generally are being directed both to the immediate objective of determining the optimum grading and design formula for various types of construction, and also to the determination of factors affecting the durability of the pavement. Studies are being made to determine the proper mixing time for bituminous mixes, and of techniques for using aggregates previously considered to be of substandard quality. This will allow for more economical construction and help to alleviate potential shortages of suitable aggregates in some specific areas.

Problems related to the mixing of asphaltic surfacings need attention. Efforts to increase production and thus hasten completion of paving projects have resulted in overloading mixers and cutting the time of mixing. The extent to which this can be done without impairing the quality of the product needs to be carefully investigated.

In the field of planning, which includes route location or modification to take advantage of favorable, natural foundation conditions, the convenient aggregate sources, as well as favorable terrain, great advances are being made in the utilization of comparatively new time- and manpower-saving methods. In this category are aerial soil survey and photogrammetry, or photographic mapping, subsurface exploration by seismic and electrical resistivity methods, and utilization, through engineering interpretation, of existing agricultural soil-survey and geologic maps and reports. Standardization of methods in this field can, as it has in others, contribute heavily to the full utilization of the new tools and to the resulting economies in manpower and time.

Field equipment and a rapid procedure have been developed and tested experimentally utilizing radioactive material for rapid determination of soil moisture and density in place. More development work needs to be done before the device can be adopted as a working tool, but this is being done. and that is important.

Soil stabilization techniques and test methods for checking the same are making possible construction of permanently stable roads. Your research on the clay mineral fraction of soils is paying off in the development of a new and easy method for determining the amount of cement necessary to stabilize soils. Already your results have indicated that this new method greatly simplifies and shortens the test procedures for determining cement requirements, and I understand related studies are under way to extend further the use of this new test method.

So when we reflect on the vastness of the studies of all of your technical committees concerning properties of the materials used in highway construction, plus the better and more efficient equipment being developed by the equipment manufacturers, added to the new techniques for utilizing this equipment, our road program indeed looks promising.

Better Highways—Key to Progress

Progress, growth, social betterment—these things are still America's manifest destiny—and you see them all in the federal-aid highway program. The indirect effects of building this system of modern highways will far exceed the limits of the program itself. Projected on a national scale, these by-products stagger the imagination. They involve an endless chain of business and industrial progress and ever-widening circles of new community growth and development. These modern expressways not only end urban congestion, but they invite the development of broad outlying areas. The economic impact of the interstate system will not be limited to its own right of way. The benefits of free-flowing traffic arteries are distributed in depth. Moreover, the vast scope of the new highway program will lend a large element of economic stability over the years. It is both a huge backlog of public works and an immediate stimulus to current economic growth.

Giant highways properly coordinated with all other means of transportation—airports, railroads and shipping—are absolutely essential for the economical distribution of people and goods, as well as for national defense and security.

In the months and years ahead, you men and your organization will play an important part in the development of our highway program, which I believe history will record as one of the greatest economic influences of this century.

Actions on Standards

The Administrative Committee on Standards is empowered to pass upon proposed new tentatives and revisions of existing tentatives, and tentative revisions of standards, as well as withdrawals of standards and tentatives offered between Annual Meetings of the Society. On the dates indicated the Standards Committee took the following actions:

Non-Ferrous Metals and Alloys

Tentative Specification for Seamless and Welded Unalloyed Titanium Pipe (B 33 - 758 T) (Accepted November 13, 1958)

Tentative Specification for Seamless and Welded Unalloyed Titanium Tubing (B 338 - 58 T) (Accepted November 13, 1958)

New Tentatives.—These specifications cover four grades of seamless and welded unalloyed titanium pipe, and unalloyed titanium tubing intended for general corrosion-resisting and elevated temperature service.

General Methods of Testing

Tentative Method of Test for Softening Point by Ring and Ball Apparatus (E 28 - 51 T) (Accepted October 20, 1958)

Revision.—There has been added to the method a molding procedure for filling the ring for heat-sensitive resins since the pour method and the powder method for preparing the sample, which are presently included in the method, are not entirely suitable for heat-sensitive resins.

Tentative Specifications for ASTM Hydrometers (E 100 - 57 T) (Accepted October 20, 1958)

Revision.—The changes made in the hydrometer specifications are the result of international activities directed toward the development of a method of test for specific gravity of petroleum products by hydrometer.

Materials for Electron Tubes and Semiconductor Devices

Tentative Recommended Practice for Testing Electron Tube Materials Using Reference Triodes (F 8 - 58 T) (Accepted November 13, 1958)

New Tentative.—This recommended practice outlines the method for construction of two types of reference triodes which may be used for evaluating tube parts. Reference tubes are useful to provide information supplementary to that obtained with production tubes.

New Viscosity Oil Standards

ON JANUARY 1, 1959, the American Petroleum Inst. will discontinue its three viscosity standards, alpha, beta, and gamma. The API program for furnishing viscosity standards, which started in 1924, will be replaced by a program under the sponsorship of the American Society for Testing Materials, Philadelphia, Pa.

The ASTM has completed arrangements with the Cannon Instrument Co., State College, Pa., for the furnishing of seven new oil standards for viscometer calibration, and the 1958 versions of ASTM Tentative Method D 445, Kinematic Viscosity, and Standard Method D 88, Saybolt Viscosity, will refer to the new series of viscosity standards.

The new standards are available from the Cannon Instrument Co. at a price of $15 per pint, F.O.B. State College, Pa.

OIL STANDARDS FOR VISCOSITY CALIBRATION

Viscosity Oil Standard Conforming to ASTM Standard	Approximate Kinematic Viscosity, cs				
	At −65 F	At −40 F	At 100 F	At 122 F	At 210 F
S 3	340	86	3	...	...
S 6	...	...	6	...	...
S 20	...	...	20	...	...
S 60	...	...	60	...	...
S 200	...	...	200	...	...
S 600	...	...	600	280	32
S 2000	...	...	2000	...	...

Viscosity Oil Standard	Approximate Saybolt Viscosity, sec		
	Universal		Furol
	At 100 F	At 210 F	At 122 F
S 3	36	...	...
S 6	46		...
S 20	100	...	...
S 60	290	...	...
S 200	970	...	...
S 600	...	150	133

World-Wide Distribution of Cotton Calibration Standards

SAMPLES of cotton fiber for use in standardizing results of fiber strength and fineness tests are being sent to laboratories all over the world through the International Cotton Calibration Standards Program. The objective of this program is to provide laboratories with a means for calibrating their instruments or for adjusting their test results to a standard level. Such standardization promises to benefit domestic and international cotton trade as well as the individual laboratory.

The ½-lb. calibration samples were chosen from three bales of American upland type cotton. One bale was selected to give low fiber strength and high Micronaire fineness value, the second bale was selected for average strength and fineness, and the third bale for high strength and low Micronaire fineness. Ten randomly selected samples from each bale were tested in five laboratories designated by the program sponsors, in order to establish standard values for the samples. All tests were made in accordance with ASTM methods. In addition to the calibration samples, interested laboratories were also provided with unknown check test samples of ginned lint. Test data from these "blind" samples are being accumulated by the program sponsors with a view to establishing practical tolerances for routine test results.

Distribution of the samples started about the middle of February, 1957. So far, 728 samples have been distributed among 176 different laboratories, 95 of which are in the United States and the remaining 81 in 14 other countries. This program was originally developed by a special task group appointed by the Subcommittee on Cotton Fibers of ASTM Committee D-13 on Textile Materials. Its sponsors are: American Cotton Manufacturers Inst., American Cotton Shippers Assn., International Federation of Cotton and Allied Textile Industries, National Cotton Council of America, and U. S. Department of Agriculture. International Cotton Calibration Standards are available from the Cotton Division, Agricultural Marketing Service, U.S. Department of Agriculture, Washington, D. C.

NEW ASTM PUBLICATIONS

Some Approaches to Durability in Structures

THE consideration of components of structures in combination, especially life in such combinations, is of importance in the durability of structures. This symposium does not deal with industrial structural metals, but rather with nonmetallic materials that are generally used in structures where weather plays a major part in the durability of the structure.

Since weather as applied to structures must be recognized as both natural and man-made and since both kinds produce factors of exposure that design engineers must cope with, the problems of variations of kinds of exposure and of associated moisture migration are considered.

This presentation is directed toward correlation between tests of some commonly used structural materials and the effects of weather on them in the hope that future methods of test for durability will be better understood by structural engineers and by code authorities, both from the standpoint of test limits which indicate unsuitability for a specific structure as well as test limits which may increase costs or be unfair to a supplier because of general considerations rather than specific needs.

CONTENTS

Introduction— E. C. Shuman

Some Factors Affecting Durability of Structural Clay Product Masonry—P. V. Johnson and H. C. Plummer

Laboratory Testing and the Durability of Concrete—T. B. Kennedy

Durability Tests of Structural Sandwich—E. W. Kuenzi and L. W. Wood

The Durability of Buildings—R. F. Legget and N. B. Hutcheon

Effect of the Atmosphere on Masonry and Related Materials—J. W. McBurney

Relation Between Actual and Artificial Weathering—F. W. Reinhart

Closing Comments—E. C. Shuman

STP 236; 74 pages; hard cover; price $2.50; to members, $2.00.

Solvent Extraction in the Analysis of Metals

IN RECENT YEARS, the analytical chemist has seen the increasing complexity of the problems more than keep pace with the spectacular advances in instrumental development so he is still vitally interested in separations processes. Among separation methods, solvent extraction enjoys a vantage position because of its speed, convenience, applicability to both trace and macro concentration levels and, in a large number of cases, because the extracted constituent is transformed into a readily measured state. Solvent extraction has been particularly helpful in the analysis of metals, and a great many extraction procedures have been utilized by analysts.

This symposium describes some recent aspects in the field. The papers included are:

Introduction—H. Freiser

Convergence of Tie Lines in Ternary Liquid Systems—Application to Liquid Extraction—R. L. Pilloton

Metals Analysis with Thenoyltrifluoracetone—F. L. Moore

The Use of Tri-*n*-Octylphosphine Oxide in Analytical Chemistry—J. C. White

8-Hydroxyquinaldine Extractions Applied to the Analysis of Metals—R. J. Hynek

The Role of Organic Solvents in Flame Photometry—J. A. Dean

STP 238; 60 pages; hard cover; Price $2.25; to members $1.80.

Mineral Aggregates and Concrete

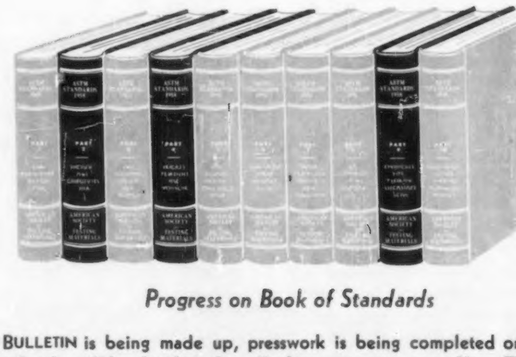
Compilation of Standards, C-9, D-4

THIS book, sponsored by Committee C-9 on Concrete and Concrete Aggregates and Committee D-4 on Road and Paving Materials, includes all of the standards prepared by Committee C-9, but only those for aggregates and other selected highway materials developed by Committee D-4. In addition, it contains pertinent specifications for cement which are under the jurisdiction of Committee C-1 on Cement. A companion book to this publication is available covering all materials of a bituminous nature used in highway construction and in the waterproofing and roofing fields.

It is believed that this publication will be useful to producers and consumers of mineral aggregates, concrete, and highway materials, as well as to specification writers, testing and inspection personnel, highway departments, and research and engineering institutions.

The book contains approximately 125 standard specifications, methods of test, recommended practices and definitions of terms for mineral aggregates, concrete, concrete curing materials, expansion joint fillers, reinforcing steel, paving block and brick, and bituminous and nonbituminous road materials. Of these, about 50 are new or revised since the 1956 edition.

ASTM Standards on Mineral Aggregates and Concrete (1958 Edition); 384 pages; paper cover; price $4.75; to members, $3.80.



Progress on Book of Standards

As this BULLETIN is being made up, presswork is being completed on Parts 4 and 9 and these books will be distributed to all whose requests are on file. These two books together with Part 2, which was available in October, will be followed shortly by Parts 3, 1, 10, 6 and 7. Our production plans are such that we expect to have these additional 5 books available for distribution shortly after the first of the new year. Parts 5 and 8 will follow.

Effect of Water on Bituminous Paving Mixtures

THE destructive effect of ordinary rainfall and the presence of water in a highway pavement may be little known to the motorist, but the highway engineer is painfully aware of the effect, as the presence of water contributes to the failure of an otherwise perfectly designed pavement.

In light of the tremendous national highway program under way throughout the nation, it is timely to make available this group of papers discussing the factors which play a significant part in the behavior of bituminous paving mixtures when exposed to the stripping action of water.

CONTENTS

STP 240; 102 pages; hard cover; price $2.75; to members, $2.20.

Books Available

THE following books, which recently became available, were reviewed in the October edition of the ASTM BULLETIN:

Compilation of Standards on Cement, C-1: 272 pages; paper cover; price $3.50; to members, $2.80.

Compilation of Standards on Plastics, D-20: 1108 pages; paper cover; price $8.00; to members, $6.40.

Compilation of Standards on Light Metals and Alloys, B-7: 344 pages; paper cover; price $4.00; to members, $3.20.

1957 Supplement to Bibliography and Abstracts on Electrical Contacts, STP 56-L: 54 pages; paper cover; price $1.75; to members, $1.40.

Symposium on Effect of Ozone on Rubber, STP 229: 136 pages; hard cover; price $3.75; to members, $3.00.

Textile Materials

Compilation of Standards, D-13

THE many ASTM standards developed by Committee D-13 on Textile Materials cover the widely used products of this industry. They provide methods of tests, tolerances within which textiles must come to make good delivery on contract, and specification requirements—standards of quality. New standard methods of test on Extractable Matter in Oven Dried Wool, Fiber Length of Wool, and Moisture in Wool by Oven Drying are included. There are 128 standards in the volume of which 30 are recently revised or have had their status changed and eight are new.

Included are terms; definitions; specifications for testing machines; methods for humidity testing, sampling, interlaboratory testing, quantitative and qualitative analysis, resistance to insect pests and microorganisms, fibers, yarns, threads, and cordage. Also included are standards for fabrics, nonwoven fabrics, hosiery, carpets, tire cord, asbestos textiles, bast, leaf fiber textiles, kraft yarns, cotton textiles; glass, man-made fiber, and wool textiles. In addition there are 16 extensive appendices, giving basic properties of textile fibers, psychrometric table for relative humidity, yarn number conversion table, and various proposed recommended practices, methods of test, methods of sampling, etc.

This compilation provides in compact, convenient form, data and information of great importance to all who deal with textile materials.

ASTM Standards on Textile Materials (1958 Edition); 880 pages; paper cover; price $7.50, to members, $6.00.

Punched Cards Indexing Spectral Absorption Data

THE Fifth Supplement of the Infrared Spectral Absorption Index Cards has recently been published by ASTM.

Beginning in 1954, ASTM through its Committee E-13 on Absorption Spectroscopy assumed the responsibility for preparing and distributing the punched IBM card system for indexing infrared and ultraviolet spectral absorption data developed at Wyandotte Chemical Corp. by L. E. Kuentzel, and subsequently adopted by ASTM Committee E-13. These cards require an IBM sorter to collate or sort out chemical compounds by absorption band patterns or related data. There are also available empirical formula - name index cards that may be sorted by hand or by mechanical sorter.

The system was designed to facilitate the sorting of spectral absorption data for the purpose of matching spectrograms in qualitative analysis and for correlating chemical structure and absorption band positions. Each index consists of standard IBM cards punched according to a standard coding system in such a way that a card corresponding to a given set of data can be mechanically sorted on a standard IBM sorter. It is possible to sort according to significant peaks in the spectra and chemical structure.

The complete deck of cards for the infrared spectral index now comprises 18,584 cards which is an expansion by five supplements from the original deck of 7705 cards issued in January, 1954. The complete deck is priced at $232.50. This includes the new Fifth Supplement which consists of 3896 cards and is priced at $49.

The infrared index cards refer to spectra found in the following sources: American Petroleum Institute Project 44, Sadtler Catalog of Spectrograms, Special group of spectra of detergents from Sadtler Catalog, NRC-NBS File of Spectrograms, Spectrograms abstracted by ASTM-sponsored groups, and Documentation of Molecular Spectroscopy.

The ultraviolet spectral absorption index is comprised of a deck of 10,935 cards expanded from an original deck of 1284 cards published in 1954 with three supplements. The complete deck of ultraviolet cards is priced at $137.50.

The ultraviolet index cards refer to spectra found in the following sources: American Petroleum Institute Project 44 and spectra abstracted from the literature by the ASTM sponsored groups.

The empirical formula - name index for infrared and related spectral data is comprised of a complete deck of 19,048 cards priced at $272. This includes the new first Supplement which consists of 5149 cards and is priced at $77. The purpose of these cards is to enable one to make a search of the index by hand to determine whether there is a published spectrum of a specific organic or inorganic compound. These cards do not carry any absorption spectral data or organic structural information.

The empirical formula - name index cards refer to the following sources of spectra: Samuel P. Sadtler and Son, Inc., American Petroleum Institute, National Research Council, abstracted from literature, Documentation of Molecular Spectroscopy.

A prospectus containing complete information on these cards may be obtained by writing to Headquarters.

ASTM Bulletin

DECEMBER 1958

NO. 234

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

10,000 Members—*But*

ASTM MEMBERSHIP is not a dry, dusty thing. It is more than receiving the publications, even though these be very extensive, and once a year arranging to send a check for the dues to cover some of the privileges. First of all, ASTM is a completely democratic organization whose basic aims are to provide all interests with a voice in reaching decisions on standards and an opportunity to participate in research and to benefit from the results.

Perhaps a case history of one company, anonymous, would be indicative. Some years back the Executive Secretary, visiting in the Middle West, was asked by the company representative if he would be interested in the figure which was included in the company's budget for participation in ASTM work. This was largely a matter of travel costs and incidental expenses, though there may have been some support of laboratory work. This was in five figures. At the surprise expressed, the member said, "Well, we consider this a very sound investment. There are any number of projects which, if we had to undertake ourselves or in collaboration even with one other organization, would cost us many times the amount we have in here for support of your activities. Through the round-robin research work and the publications issued, we get back in technical value many many times our investment."

When one considers that for 30 cents he can buy a complete specification covering the quality and the testing of structural steel and realizes what would be entailed if a separate document had to be written each time a building or a bridge is designed, some idea of the tremendous cost saving is evident.

Membership in the Society provides another very valuable asset, we think, and that is the opportunity for an individual or a company, through different technical people, to be alert to developments across a wide variety of materials fields. Through ASTM standards and publications, there is provided authoritative information and the latest data on properties and tests.

10,000 Members

Of course it is gratifying to note that sometime in 1959 the total membership of the Society will reach 10,000. It is something on the order of 9700 at this writing. It does not seem so long ago when the membership curve was quite different. In the early 1930's following the depression, it dropped down from a high of 4400 into the high 2000's and it took almost 12 years to get back to the 1929 figure of 4400. However, though Headquarters people and membership committees and directors like to see curves on the upward grade, sometimes comparisons are odious. For example, it is not exactly correct to indicate size of the Society by comparing a membership of 10,000 with the '42 figure of 4400—for the reason that there are now almost 6000 members of technical committees who represent company and association memberships, not being personally affiliated with ASTM. Adding to this some 6000, about 3500 actual members—individuals or official representatives of companies—we have about 9500 different individuals serving on the some 2500 technical committees (including the subcommittees and sections of the 80-odd main technical groups). In a sense, this is again one of the dynamic attributes of membership. Each of these, to a greater or less extent, is contributing of his knowledge, his skills, his administrative abilities in advancing ASTM work, and in turn receiving the benefits from the knowledge and skills of his associates.

When one looks at the new 790-page *Year Book* (sent to members on request) and realizes that almost 400 pages are devoted to a listing of the personnel of committees, there is some concept of the dynamic force that is ASTM.

By all means, let us try to reach the 10,000 membership figure as soon as possible. More members mean more people benefiting from the technical data and especially more people helping to promote the use of standards which industry today recognizes brings back many fold the investment in the standards development. One very large company which has kept rather good statistics indicates that the figure has grown in recent years from around five- to sixfold return to at least ten.

What has made the Society great is the splendid cooperative effort of the members and the committee members. In a broad sense every member can get gratification from his support of the Society.

Offers of Papers for 1959 Meetings

Annual Meeting, June 21–26, Atlantic City, N. J.
Third Pacific Area National Meeting, October 11–16, San Francisco, Calif.

THE Administrative Committee on Papers and Publications will meet early in 1959 to consider the papers to be published by the Society in 1959 and to develop the program for the Annual Meeting in June and the Third Pacific Area National Meeting in October.

All those who wish to offer papers for presentation at these meetings and for publication by the Society should send these offers to headquarters not later than January 1 for the Pacific Coast papers and January 10 for the Annual Meeting papers.

All offers should be accompanied by a summary which will make clear the intended scope of the paper and which will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the programs of the Annual Meeting or Pacific Area National Meeting.

Suitable forms for use in transmitting this information will be sent promptly upon request to headquarters.

1959 Nominating Committee

In accordance with the Bylaws of the Society, which provide that the Board of Directors shall select a nominating committee for officers, the Board has considered the report of the tellers—G. D. Patterson and J. S. Roberts—recommending members of the nominating committee, and has appointed the members shown below. Serving on the 1959 Nominating Committee as *ex officio* members are the three immediate past-presidents: C. H. Fellows, R. A. Schatzel, and R. T. Kropf. The committee will meet in February and will nominate for the offices of President, Vice-President, and Directors. Their selections will be announced in the ASTM Bulletin prior to transmission of the official ballots.

Members	Alternates
L. H. Winkler, Bethlehem Steel Co. (Retired)	A. O. Schaefer, Pencoyd Steel and Forge Corp.
D. E. Parsons, National Bureau of Standards	W. H. Price, U. S. Bureau of Reclamation
R. C. Alden, Phillips Petroleum Co. (Retired)	W. E. Scovill, Standard Oil Co. (Ohio)
A. A. Jones, Anaconda Wire and Cable Co.	V. P. Weaver, The American Brass Co.
R. B. Crepps, Purdue University	J. J. Hazel, Republic Steel Corp.
W. A. Gloger, National Lead Co.	N. C. Schultze, Olin Mathieson Chemical Corp.

Headquarters Repository for Committee Research Reports

There is being established at ASTM headquarters a file facility for use by the technical committees so that research information developed in the committees may be made available for later use. While it is desirable to publish in the Bulletin and *Proceedings* many reports of this nature that have been suitably reviewed and edited, it is not considered feasible economically or otherwise to publish all such reports in the detail that would be useful. The Headquarters Research Report file will enable the orderly storage and retrieval of reports that are too extensive, too detailed, or too specialized for regular publication but which should be available for later reference to avoid useless repetition of investigations.

Papers Welcome for *Mass Spectrometry Symposia*

A symposium on pyrolysis and other degradations is being organized as part of the program for the Seventh Meeting on Mass Spectrometry, under the sponsorship of Committee E-14, which will be held at the Statler Hilton Hotel in Los Angeles during the week of May 17, 1959. A special effort is being made to arrange additional symposia of theoretical and analytical interest.

Authors are requested to submit an abstract of their papers to the co-chairman of the subcommittee on program and papers, A. G. Sharkey, Jr., U. S. Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa. Contributed papers are welcome on all phases of mass spectrometry.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
Jan. 13	**New York District**	New York, N. Y.
Jan. 14	**Chicago District**	Chicago, Ill. (LaSalle Hotel)
Jan. 14–16	**Committee A-1 on Steel**	Chicago, Ill. (LaSalle Hotel)
Jan. 19–21	**Committee D-1 on Paint, Varnish, Lacquer and Related Products**	Columbus, Ohio (Deshler-Wallick Hotel)
Jan. 21	**Washington, D. C., District**	Raleigh, N. C. (N. C. State College)
Jan. 25–28	**Committee D-19 on Industrial Water**	Savannah, Ga. (General Oglethorpe Hotel)
Jan. 28–29	**Committee D-7 on Wood**	Madison, Wis. (Forest Products Laboratory)
Feb. 1–6	**Committee D-2 on Petroleum Products and Lubricants**	St. Louis, Mo. (Sheraton-Jefferson Hotel)
Feb. 2–6	**COMMITTEE WEEK**	Pittsburgh, Pa. (Penn-Sheraton Hotel)
Feb. 4–6	**Committee D-16 on Industrial Aromatic Hydrocarbons and Related Materials**	St. Louis, Mo. (Sheraton-Jefferson Hotel)
Feb. 16–18	**Committee D-20 on Plastics**	Washington, D. C. (Sheraton Park Hotel)
Feb. 18–20	**Committee D-9 on Electrical Insulating Materials**	Washington, D. C. (Sheraton Park Hotel)
Feb. 25	**Southwest District**	Houston, Tex.
Feb. 25	**Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts**	Washington, D. C. (Mayflower Hotel)
Feb. 25	**Southwest District**	Houston, Tex. (Rice Institute)
Feb. 25–27	**Committee D-6 on Paper and Paper Products**	New York, N. Y. (ASA Headquarters)
Feb. 26	**Southwest District**	Houston, Tex.
Feb. 26–27	**Committee F-1 on Materials for Electron Tubes and Semiconductor Devices**	Washington, D. C. (Mayflower Hotel)
March 2	**Southwest District**	College Station, Tex. (Texas A. & M.)
March 3	**Southwest District**	Dallas, Tex. (Southern Methodist Univ.)
March 4	**Southwest District**	Norman, Okla. (Oklahoma Univ.)
March 6	**Rocky Mountain District**	Salt Lake City, Utah (University of Utah)
March 9	**Southern California District**	Los Angeles, Calif. (Roger Young Audit.)
March 11	**Northern California District**	Berkeley, Calif. (University of Calif.)
April 5–10	**Fifth Nuclear Congress**	Cleveland, Ohio
April 13–14	**Committee D-15 on Engine Antifreezes**	Washington, D. C. (Shoreham Hotel)
April 13–14	**Committee D-10 on Shipping Containers**	Chicago, Ill.
April 29	**Detroit District**	Detroit, Mich.
April 30	**Pittsburgh District**	Pittsburgh, Pa.
May 18–22	**Committee E-14 on Mass Spectrometry**	Los Angeles, Calif. (Statler Hotel)
June 21–26	**ANNUAL MEETING**	Atlantic City, N. J. (Chalfonte-Haddon Hall)
Oct. 11–16	**THIRD PACIFIC AREA NATIONAL MEETING**	San Francisco, Calif. (Sheraton-Palace Hotel)

ASTM and Cooperative Research

By FRANK T. SISCO[1]

About two years ago I wrote in this space about cooperative basic research. I defined this as research organized and undertaken by a professional society, by an industrial trade association, or by a group of companies in a particular field, to solve a fundamental problem common to that field. Cooperative basic research is generally financed by industry or by the trade association that represents industry, and it is characterized by several inherent advantages. The principal advantage is that such research is efficient, because the collective skills and experience of a carefully selected committee of experts in the field are available for planning the work and for guiding it. As a corollary to this the overhead is low because supervision is largely supplied voluntarily by such a committee. An additional advantage is that the financial burden is distributed.

The theme that was stressed in this earlier article was that industry in general is hesitant about supporting cooperative basic research, primarily because such research has no immediate practical application and has a comparatively long time factor. It was further stated that industry frequently does not clearly recognize the importance of such long-time cooperative effort and is, consequently, not aware of its value. I pointed out that industry is quick to support practical cooperative research if an entire industry (for example, soap) is economically threatened by the rapid rise of a new industry (detergents) or if it is necessary to organize and carry on investigations in order to find new outlets for the threatened industry's products. A liberal attitude toward cooperative research on the part of industry is also apparent if the industry is faced with punitive legislation, as in air and water pollution.

Industry Favors Joint Research

In the two years that have elapsed since this article was printed, I have had an opportunity to discuss my views on industry's hesitancy in cooperating in basic research with the research directors of several of this country's leading corporations with the result that this apparent lack of industrial interest in such research has been placed in an entirely new light. I am now convinced that industry in the United States is interested in research to an extent far beyond solving its own immediate problems. I am also convinced that industry favors cooperative research carried on to solve fundamental problems common to its field, and that if these problems are presented to industry in the right light it will support such research generously. What industry lacks is an impartial source of such problems, and an impartial stimulus to secure the necessary cooperation.

Competition being what it is in this country, it is natural that any single company in any specific field would be hesitant about approaching its competitors with a proposal to get together in organizing, financing, and carrying to completion a long-term fundamental research project. But if an impartial and representative body of experts, set up by a professional society, would study a field and propose a research program to solve the pressing basic problems in this field, I am convinced that industry would cooperate wholeheartedly. Such cooperation has already been demonstrated—at least for applied research and, to some extent, for basic research—by the excellent research programs of The American Society of Mechanical Engineers, the Engineering Foundation, the American Petroleum Institute, and the American Iron and Steel Institute (to mention only a few), for which industry supplies virtually all of the support.

ASTM Can Help

ASTM, and its technical committees, is a collection of experts in industrial materials that is made to order to inspire, organize, and supervise either basic or applied industry-wide cooperative research in materials, and the Society's Administrative Committee on Research is an ideal organization to stimulate such endeavors. In fact, the ACR has already prepared a foundation for such stimulation in its "Challenges in Materials Research," which lists more than sixty unsolved problems of importance. In addition, the ACR has available a small fund, part of which could be used to underwrite the cost of organizing and securing the initial financing of a project if circumstances warrant such a step.

ASTM, despite its world-famous activities in standardization, is essentially a society that is concerned with research and development in materials. The amount of cooperative research that is undertaken in connection with the Society's standardization activities is enormous, and it is unfortunate, both for the Society and for materials engineers, that most of this cooperative research is never prepared for publication and is consequently lost to all but a few. On the other hand, ASTM has occasionally been the guiding light in cooperative research of high quality and importance. Two such projects with which I am personally familiar are the outstanding investigations called "Effect of Temperature on the Properties of Metals" and "Wood Pole Research." ASTM should be the sponsor of many more such projects.

Organizational Funds Available

It is only fair, I think, to end this brief statement of the advantages of society-sponsored cooperative research and this appeal that ASTM take a more prominent part in stimulating such research, by mentioning some of the attending difficulties. In the first place, a need for a chosen field of research must be proved. (In the field of materials, the ACR's "Challenges in Materials Research" has already clearly shown that the need is there.) In the second place—and this is more serious—one or more individuals must be found who are enthusiastic enough about the proposed research to undertake the arduous and time-consuming work that precedes the organization of a project. Furthermore, some funds should be available for organizational purposes, to defray travel expenses where necessary and to prepare brochures and other material needed for an approach to industry for financial support. As indicated above, I feel that the Administrative Committee on Research or the ASTM Board of Directors would, if properly approached, be willing to provide the small sum necessary.

[1] Director, Engineering Foundation, New York, N. Y.

Industrial Chemicals

Organization Meeting Early in '59

THE Society will formally organize the new Committee E-15 on Analysis and Testing of Industrial Chemicals at a meeting to be held early in 1959. The organizing committee, W. A. Kirklin of Hercules Powder Co., chairman, at its meeting at ASTM headquarters in October, completed a number of recommendations to expedite the business at the organization meeting.

To be presented at the organization meeting are suggestions on projects that might be undertaken by subgroups. Three general categories of subgroups were suggested, one along product lines covering such materials as alcohols and ketones, and mineral acids. Another major group of projects might cover analysis for various physical properties and determination of functional groups. These might include determination of density, molecular weight, pH, etc., as well as determination of such functional groups as carbonyl, carboxyl, ester, ether, etc., and elemental analysis. A third group might be under the category of techniques, some of which are already covered by ASTM committees, for example, E-2 on Emission Spectroscopy, E-13 on Absorption Spectroscopy, and E-14 on Mass Spectrometry with which the new committee will cooperate. The new committee might also cover such techniques as separations by crystallization, ion exchange, and determinations by colorimetry, visual titrimetry, conductance, potentiometry, polarography, etc. It was also pointed out that work is needed in the areas of sampling, precision, and accuracy and it might be desirable to establish groups on these subjects.

A list of interested companies and individuals is being prepared at Headquarters, to which invitations to the organization meeting will be sent. Sources of information have included the Year Book listings of analytical subgroups of existing technical committees, suggestions by members of the organizing committee, and expressions of interest as a result of the notice that appeared in the September ASTM BULLETIN. The invitation list is still open and expressions of interest in active participation in the new committee should be addressed to ASTM Headquarters.

The tentative scope of the committee, as approved by the Board of Directors, appeared in the September ASTM BULLETIN, page 20.

Electronic Parts Cleaning

A Few Atoms Out of Place Can Do Damage

PARTICLES so small that 200 to 20,000 of them can be placed side by side within the diameter of a 2.5 mil human hair can have an important effect on the performance and life of an electron tube, a semiconductor device, or a precise instrument with moving parts. Such particles have a surface area measured in terms of acres per gram. Organic materials, and especially sulfides, on particles contained within a tube can cause serious malfunction and shortness of life of the cathode.

An extensive exchange of information on techniques for removing such particles from tube parts and for maintaining the parts in the clean condition during assembly was provided in the 2-day Symposium on Cleaning of Electronic Device Components and Materials, held in October in Philadelphia, and sponsored by ASTM Committee F-1 on Materials for Electron Tubes and Semiconductor Devices.

According to J. W. Faust, Jr., of Westinghouse Electric Corp., semiconductors also require the extreme care and cleanliness in preparation as do electron tubes. Steps in producing semiconductor devices include the slicing of semiconductor crystals into thin wafers and subsequently lapping the surface of these wafers to a high degree of perfection. Mr. Faust pointed out that a single large particle (10 microns) in a grinding compound of fine particles (0.1 micron) can cause extensive surface damage which, because of the elastic nature of semiconductor crystals, is reflected deep into the interior, these dislocations acting as recombination centers for electrons and holes. Such recombination centers, whatever the cause, have been referred to as "deathnium."

Some new light concerning nature's best solvent, water, was provided by M. V. Sullivan of the Bell Telephone Laboratories. Mr. Sullivan has succeeded in generating intrinsic water using a special ion exchange bed. Intrinsic water derives its conductivity solely from ionization of the water molecule and, therefore, has powerful dissolving capabilities for trace quantities of ionic impurity. Intrinsic water cannot be held or transported, as it dissolves a portion of the container or pipe line; it must be generated and used immediately. Mr. Sullivan described such a generator where tube parts are washed in a fountain of intrinsic water which is then recirculated through the ion exchange bed. Intrinsic water removes traces of ionic impurity which, if left on the tube parts, could result in electrical leakage paths between elements of the tube. Intrinsic water is also useful in cleaning semiconductor parts.

J. W. Faust, Jr., Westinghouse Co., describes semiconductor lapping problems.

Extremely small amounts of organic contaminants, equal to no more than one-tenth of a monomolecular layer can be detected by a spray test described by D. O. Feder of Bell Telephone Laboratories. The importance of small amounts of organic contaminants on surfaces is evident when it is realized that recently developed electron tubes may have a ratio of tube-parts area to cathode area of six million to one whereas older tubes were of the order of fifty to one. The life of the electron tube cathode, its most crucial element, may be more dependent upon the impurities and contaminants on tube parts than upon the composition of the cathode itself.

Some 250 people attended the symposium on cleaning. It was evident from the papers and the discussions that present efforts will need to be extended and that cleaning is of great importance to the electronic and mechanical industries.

The papers and discussions will be published by the Society.

District Activities

President Woods at District-University Meetings in Southeast

President Woods, Executive Secretary Painter, and Professor Paquette chat at rostrum during Southeast District Meeting in Atlanta, Ga.

During the week of October 6, President K. B. Woods, head of the School of Civil Engineering, Purdue University, accompanied by Executive Secretary R. J. Painter, attended joint meetings held at four leading engineering schools, namely, University of Florida, Georgia Institute of Technology, University of Tennessee, and University of Kentucky. Except at Georgia Tech, Professor Woods gave his very interesting talk on Polar Construction (see New England District story, page 19) based on his many travels to Alaska and the Arctic regions. He discussed the problems of building on permafrost, the acute problems of water and sanitation, and showed a number of excellent Kodachrome slides taken both on the ground and from the air. There was naturally much interest in the talk because of Alaska coming in as our forty-ninth state, and considerable reference was made to this area.

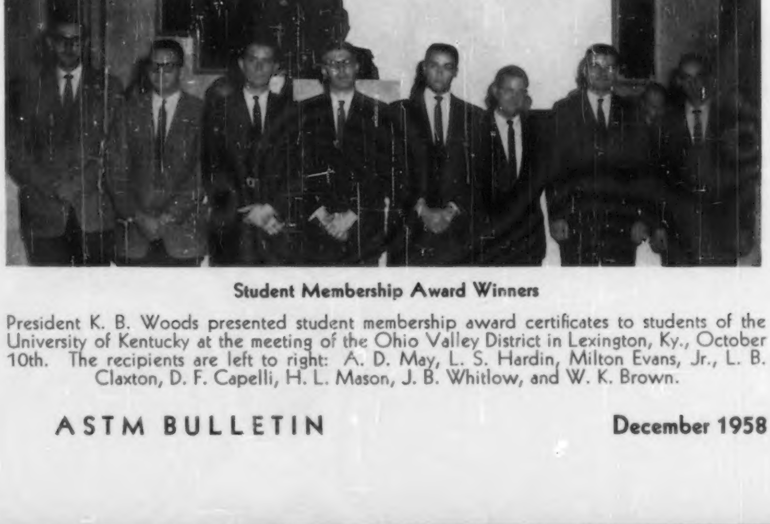
In Atlanta, where the meeting was held at Georgia Tech, the president discussed the topic, "Stretching Your Highway Dollar through Research." He outlined how some of the research organizations are currently set up, particularly those sponsored by states, commented on the Federal highway program, and stressed the cooperative efforts made in organizations such as ASTM and the American Association of State Highway Officials.

At each of the meetings there were a number of former associates or students of Professor Woods from Purdue who greeted him and in fact assisted in arrangements for the meeting. At the University of Florida, in Gainesville, Prof. Ralph Kluge, head of the Civil Engineering Department, was the host. Among others were the Dean of Engineering Weil and Professor Grinter, dean of the Graduate School, who headed the committee which presented the very important ASEE report on Engineering Education.

In Atlanta, Prof. Radnor J. Paquette, School of Civil Engineering, made the arrangements for the dinner prior to the meeting and the meeting being sponsored jointly with the Georgia Tech Research Institute. Harry Baker, president of the institute, was present and, among others, M. L. Shadburn, state highway engineer, Georgia State Highway Department. The audience included many leaders in the highway field in Georgia.

At Knoxville, Prof. E. A. Whitehurst, associate director of the Engineering Experiment Station, made arrangements. Dean of Engineering, A. T. Granger, Prof. E. S. Fabian, head of the Civil Engineering Department were among the faculty people present at the dinner and meeting.

At Lexington, following luncheon with some twenty of the engineering faculty, there was a seminar with faculty members and graduate students, dealing with the engineering curriculum; but the evening meeting held at the Phoenix Hotel was sponsored jointly with the Kentucky Society of Professional Engineers with an excellent attendance. Cooperating closely in this meeting were W. B. Drake, associate director of research, Materials Research Laboratory, Kentucky Department of Highways, and Phil M. Miles, president of the Blue Grass Chapter, Kentucky Society of Professional Engineers. Prof. D. K. Blythe, head of the Department of Civil Engineering, ably acted as host at the University.



Student Membership Award Winners

President K. B. Woods presented student membership award certificates to students of the University of Kentucky at the meeting of the Ohio Valley District in Lexington, Ky., October 10th. The recipients are left to right: A. D. May, L. S. Hardin, Milton Evans, Jr., L. B. Claxton, D. F. Capelli, H. L. Mason, J. B. Whitlow, and W. K. Brown.

Actually these four meetings were sponsored by three ASTM Districts—those in Florida and Atlanta by the Southeast District; Knoxville by the Washington, D. C., District; and Lexington by the Ohio Valley District. Several of the Ohio Valley officers came considerable distances to the Lexington meeting.

All of the meetings were held jointly with some group, usually the local section or chapter of the American Society of Civil Engineers or the student chapter. At Gainesville, the "civils" were well represented by Dr. E. R. Hendrickson, associate research professor, who is chairman of the Florida Chapter of ASCE, and by Prof. C. C. Hill, who heads the Gainesville Section. At Georgia Tech, Prof. Robert Stiemke, director of the Department of Civil Engineering, greeted the visitors.

During his presidential year, Professor Woods plans to visit many other leading engineering schools, discussing with faculty members the problem of engineering curricula in the field of materials and engineering broadly, as well as giving one of his talks designed for districts dealing either with polar construction, highway research, or a more formal review of developments in engineering training.

Social Hour at the Southeast District Meeting in Atlanta, Ga.

(Left to right) A. R. Brickler, regional engineer, Portland Cement Assn.; Harry F. Baker, Jr., assistant director, Engineering Experimental Station, and president, Research Institute, Georgia Institute of Technology; K. B. Woods, head of the School of Civil Engineering, and director, Joint Highway Research Project, Purdue University, president, ASTM; T. W. Jackson, chief of the Mechanical Science Division, Engineering Experimental Station, Georgia Institute of Technology; Radnor J. Paquette, professor, Civil Engineering, and research associate, Georgia Institute of Technology; Curtis J. Blackman, superintendent, Metals and Inspection Department, Atlantic Steel Corp.

NEW ENGLAND

President Woods Speaks on Polar Construction

"Permafrost" (permanently frozen ground) covers approximately one-fifth of the land surface of the world, and in the Arctic, and other northern areas, permanently frozen ground extends to a depth of 1000 ft. or more, according to ASTM President K. B. Woods in his address, "Engineering Problems in the Arctic," given at a joint meeting of the ASTM New England District, the Massachusetts Section of the American Society of Civil Engineers, and the Boston Society of Civil Engineers.

Engineering problems in this vast northland present considerable difficulty. Important consideration must be given to water supply, sanitation, and the location sites of buildings, airfields, and highways. Foundations are especially troublesome.

Severe as the design problems caused by permafrost may be, Prof. Woods remarked that they could be even severer in the Sub-Arctic regions. In the regions of permafrost, the design of pavements is controlled largely by the thickness of pavement necessary to protect against thawing, while in the Sub-Arctic regions the design is controlled by the thickness required to prevent frost penetration into the underlying frost-susceptible soils. This means, Professor Woods stated, that in some instances the thickness required to prevent penetration of frost may be even greater than the thickness required farther north to prevent thawing of the permafrost.

The dinner at the Massachusetts Institute of Technology Faculty Club, Cambridge, Mass., October 30, was attended by approximately 175 people, who were later joined by additional members wishing to hear Professor Wood's talk and to see his color slides of the construction work for which he has been consultant in the Arctic and the Sub-Arctic.

NORTHERN CALIFORNIA

Peaceful Atom Uses Predicted

At a joint meeting of ASTM Northern California District, the Nuclear Division, ASME, and Power Division, AIEE held Monday, November 3 in San Francisco, Col. David D. Rabb of the University of California Radiation Laboratory discussed peaceful applications of nuclear energy. Much of his talk was based on the Atomic Energy Commission Hardtack 2 Series at the Nevada Test Site. This is part of the Project Plowshare in which the AEC seeks to find peaceful uses for atomic explosions. Among the possibilities are excavations, direct power production, recovery of oil from shale, and breaking underground deposits of low-grade ore.

Col. Rabb discussed the safety, feasibility, and economy of nuclear detonations. Interesting situations which might lead mining and allied industries to use atomic explosions were outlined. Col. Rabb also showed a color film prepared by the University of California laboratories entitled, "Industrial Uses of Nuclear Explosions." This film was prepared for the recent Geneva Conference.

The success of the luncheon reflects the efforts of the District Council officers. Chairman Gray was assisted by E. W. Bowman as luncheon chairman. In this he had the cooperation of Messrs. Boynton, Bloom, Dice, Ruhling, Garlock, Kimber, Kramer, Poole, and Wiley.

Meetings of this kind are all too infrequent. Nevertheless, a luncheon of this kind in Washington provides an excellent opportunity for many of our Government members, associates, and friends to get together with representatives of industry and associations as well as national officers.

PHILADELPHIA

Sprague Speaks on "Reliability and the Defense Program"

"The urgent need for greatly improved reliability in the complex weapons systems of today . . . has been amply demonstrated by our failures in the long range missile and satellite launchings," according to Jullian K. Sprague, president of the Sprague Electric Co. and well-known authority in the electronics industry. "The necessary degree of improvement can be achieved only with component parts approaching absolute reliability," he continued in his address, "Reliability and the Defense Program," given at a joint meeting of the Philadelphia District and Committee F-1 on Electronic Materials, Monday, October 13, in Philadelphia.

"The concept of high reliability itself is not easy, and it may take considerable time . . . before a common understanding is reached and a plan agreed upon. This initial phase must be followed by exhaustive engineering, and evaluation tests of numerous designs to determine the best. Incoming material and inspection procedures must be established to assure material of high and uniform quality; clean manufacturing space, perhaps with filtered, cooled, and humidity-controlled air, must be installed; meticulous manufacturing methods with adequate in-line tests and quality assurance procedures are essential; and elaborate and extensive end-of-the-line test equipment of many types must be set up.

"All this, and the careful training and selection of manufacturing personnel, is time consuming and can be very costly . . . for there is no possible way by which one can determine whether the design goal has been achieved until tens of thousands of units have been built and several million unit hours of destructive life tests have been logged. If insufficient reliability is then indicated, it means starting all over with a new design."

Mr. Sprague was introduced by Robert J. Painter, executive secretary of ASTM. Allan H. Kidder, Philadelphia Electric Co., acted as toastmaster at the dinner meeting which was part of a two-day symposium on the Cleaning of Electronic-Device Components and Materials (See page 17), sponsored by Committee F-1. Symposium chairman F. J. Biondi, Bell Telephone Laboratories, made arrangements for the program and meeting in conjunction with the Philadelphia District.

PITTSBURGH

Hutcheson Describes Materials Advances

At a joint meeting of the Pittsburgh District, ASTM and the Pittsburgh Section of the American Institute of Electrical Engineers, held Tuesday, November 11 at the Westinghouse Research Laboratories, Dr. John A. Hutcheson, vice-president for Westinghouse discussed Engineering Materials in Electrical Equipment.

Three basic reasons were given by Dr. Hutcheson, for our great advances in recent years in power generation, namely, the discovery of new scientific principles, the utilization of new designs, and the advent of new materials. The discovery of new scientific principles is a rarity and new designs are often dependent on the availability of new materials. Dr. Hutcheson cited several examples to illustrate his point. For example, early in the history of the electrical industry it required 23,000 Btu to produce 1 kw of electricity. Now the requirement is approximately 8000 Btu per kw. This is the result of better steam turbine designs which in turn have developed through the availability of super alloys capable of withstanding high pressures and high temperatures.

Other examples in generators and in electric light bulbs were cited. For example, early 60-w bulbs cost $1.25 and produced only 475 lumens. Today's 60-w bulbs, which retail for approximately 20 cents, produce 825 lumens and last twice as long.

New materials are vital to the advances we make, and materials research is the key to new materials. Dr. Hutcheson demonstrated several new materials which have resulted from the research work being done at the Westinghouse Laboratories. These included Luminescent Panels and magnetic metal, polar in two directions.

Among those attending the dinner prior to the technical talk were W. R. Harris, chairman, Pittsburgh Section, AIEE; L. W. Tarn, vice-chairman, Pittsburgh Section, AIEE; Henry Ball and H. F. Beegley, former chairmen of Pittsburgh ASTM District. Arrangements for tours and demonstrations were handled by Dr. G. Sommerman of Westinghouse Laboratories. Dr. Romualdi, Carnegie Institute of Technology and chairman of the ASTM Pittsburgh District, presided at the meeting. Mr. Harris introduced the speaker.

Head Table at the Joint Committee F-1—Philadelphia District Dinner

(Left to right) C. M. Ryerson, administrator, Equipment Maintainability and Reliability Defense Electronic Products, Radio Corporation of America; W. F. Bartoe, chief physicist, Research Division, Rohm & Haas Co., secretary, Philadelphia District Council; Thomas W. Hopper, president, Day & Zimmermann, Inc., chairman, Philadelphia Section, American Society of Mechanical Engineers; S. A. Standing, Raytheon Manufacturing Co., chairman, Committee F-1; H. L. Bowman, dean of the faculty, Drexel Institute of Technology, Philadelphia, Pa.; E. J. Albert, chairman of the board, Thwing Albert Instrument Co., member, Philadelphia District Council; A. Scala, vice-president in charge of Chatham Electronic Division, Tung-Sol Electric Co.; Harold L. Maxwell, retired, engineering consultant, E. I. du Pont de Nemours and Co., Inc., ASTM past president; Carl C. Chambers, vice-president in charge of engineering affairs, University of Pennsylvania; Robert J. Painter, executive secretary, American Society for Testing Materials; Julian K. Sprague (speaker), president, Sprague Electric Co.

PHILADELPHIA

Student Awards Given

THE Philadelphia District presented its annual student awards at a meeting held Thursday, November 20, at Villanova University. The featured speaker was Prof. K. B. Woods, president of ASTM.

Among those attending the meeting were Prof. George Auth, head of the Mechanical Engineering Department of Villanova, Prof. Joseph E. Greyson, in charge of materials testing, and Dean J. Stanley Morehouse, dean of engineering. Also present were: Prof. W. E. Schmid of Princeton University, Prof. L. P. Mains of Drexel Institute, and Prof. Percival Theel of Philadelphia Textile Inst.

The meeting was opened by Allen Kidder, chairman of the Philadelphia District Council, who introduced Robert J. Painter, Executive Secretary, ASTM. Mr. Painter described the history of the Student Award Program and the interest that the ASTM holds in engineering education. Following this, the student awards were presented to 28 students from eight colleges and universities. Chairman Kidder presented the students to Prof. Woods who distributed the award certificates as each student was introduced.

Professor Woods then presented his lecture on "Polar Construction," graphically showing the hazards and difficulties encountered by engineers in the far North.

More than 125 students, engineers, and scientists attended the meeting. It was held in cooperation with the Philadelphia section of the American Society of Civil Engineers.

Student Membership Award Winners

President K. B. Woods presented student membership award certificates to 28 students from eight colleges and universities at a dinner meeting of the Philadelphia District at Villanova University Thursday, November 20.

CHICAGO

Explorer Describes Primitive Materials

Sponsored by the Chicago District in conjunction with a meeting of Committee D-10 on Shipping Containers, Dr. Llewelyn Williams, naturalist and explorer, discussed "Exploration of the Amazon Basin and Its People," Dr. Williams, who traveled with only native guides through the rough Amazon country from the Atlantic through the Peruvian Andes, illustrated his talk with scenes of the rivers, life, and conditions in the area. He described the methods used by the natives to harvest and process such natural products as crude rubber, gums, resins, essential oils, and timbers.

The meeting, held October 16 at Madison, Wis., drew a large audience from both the Chicago District and Committee D-10. Dean Kurt F. Wendt, College of Engineering, University of Wisconsin, served as toastmaster with Emeritus Dean M. O. Withey as vice-toastmaster. Arrangements for the meeting were made by Past-President L. J. Markwardt, U. S. Forest Products Laboratory.

DETROIT

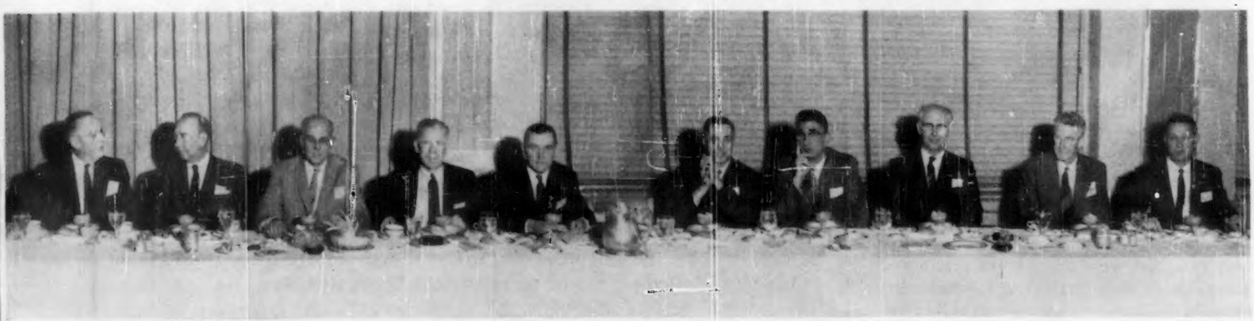
Paints Spur Product Sales

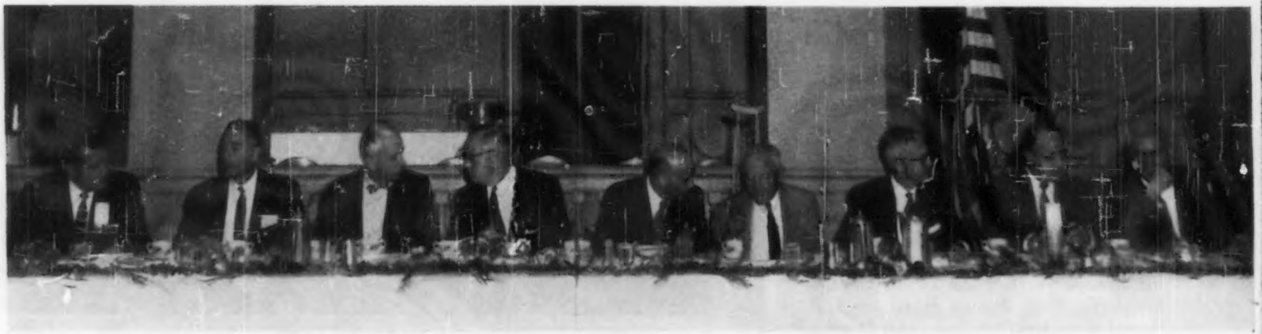
Dr. Newell P. Beckwith, vice-president and technical director, Rinshed-Mason Co., speaking before a joint meeting of the ASTM Detroit District and the Detroit Paint, Varnish and Lacquer Assn., Monday evening, November 10, discussed "Painting to Sell Your Product."

Dr. Beckwith has served as secretary and treasurer in the Paint Research Institute, as a member of the Board of Directors of the Canadian Paint, Varnish and Lacquer Assn. and as a member of the Canadian Government Specifications Board.

Arrangements for the meeting were made by E. L. Morrison, The Budd Co., program chairman for the ASTM Detroit District.

A. H. Kidder, Philadelphia Electric Co., chairman, Philadelphia District; Brig. General Edwin R. Petzing, Advisory Group on Electronic Parts, Office of the Assistant Secretary of Defense; A. M. Glover, vice-president and general manager, Semiconductor and Materials Division, Radio Corporation of America; N. L. Mochel, manager, Metallurgical Engineering, Westinghouse Electric Corp., ASTM past-president; R. P. Liversidge, vice-president in charge of operations, Philadelphia Electric Co.; F. J. Biondi, chemist, Bell Telephone Laboratories, vice-chairman, Committee F-1; Henry F. Argento, vice-president and general manager, Government and Industrial Division, Philco Corp.; W. R. Turner, division manager, Military Field Service Division, Burroughs Corp.; Stanton Umbreit, metallurgist, Tube Division, Radio Corporation of America, secretary, Committee F-1; Harry Kimel, manager projects, Technical Support Operations, General Electric Co.





Some of the People Attending the Washington, D. C., District Meeting

(Left to right) E. W. Bauman, managing director, National Slag Assn.; A. B. Cornthwaite, testing engineer, Department of Highways, Commonwealth of Virginia; E. H. Holmes, assistant commissioner for research, Bureau of Public Roads; Fred Burggraf, director, Highway Research Board; A. Allan Bates, vice-president of research and development, Portland Cement Assn., vice-president, ASTM; Arno C. Fieldner, past-president and honorary member, ASTM; R. J. Painter, executive secretary, ASTM; Ellis L. Armstrong, commissioner, Bureau of Public Roads; K. B. Woods, head of the School of Civil Engineering, Purdue University, president, ASTM.

WASHINGTON, D. C.

President Woods Speaks on Highway Materials Before Interested Government Officials

AT A LUNCHEON attended by leading officials of the Bureau of Public Roads and other Government departments in Washington, with about 135 members, committee members of the Society, and guests present, President K. B. Woods gave an interesting talk on, "Highway Materials." The meeting was held at the Hotel Mayflower under the auspices of the Washington District, Wednesday, November 19.

The accompanying photograph and caption lists those at the head table including past presidents, directors, and Bureau of Public Roads' officials. Ellis Armstrong, the newly appointed Commissioner of Public Roads, attended.

Preceding President Woods' pertinent talk, Executive Secretary Painter briefly commented upon the Society's intensive interest in engineering education, noting some of the latest developments including a new administrative committee on fellowships and the extensive symposium planned jointly with the American Society for Engineering Education in Atlantic City on Monday, June 22.

President Woods, choosing "Highway Materials" as his subject, emphasized the great strides made in our methods of evaluating the qualities of materials and in developing standard tests specifications for them. For example, he noted that if the present tremendous highway program were imposed on what we knew about soils and how to evaluate them in 1920, the program would be impossible. As a matter of fact, it was not until the late 1930's and early 1940's that, largely thorough ASTM Committee D-18, classifications had been set up and agreement reached on standard methods of determining important properties allied to the building of highways.

He noted the longtime use of cement and asphaltic and related materials, over one hundred years, and then elaborated a bit on ASTM developments in these fields.

He paid tribute to the great support of the ASTM research and standards work by the Bureau of Public Roads. Past-President L. J. Markwardt, Forest Products Laboratory, Madison, Wis., and ASTM Vice-President, A. Allen Bates, Portland Cement Assn., were in Washington attending meetings of the Building Research Advisory Board and came to listen to the president speak.

Papers to Appear in Future Issues of the ASTM BULLETIN

Extending Concrete Highway Durability with Silicones by H. L. Cahn and R. V. Mackey, Jr., General Electric Co.

A New Method for Determining the Wet Adherence of Supported Films to Various Substrata by A. S. Diamond, Eastman Kodak Co.

Further Development and Use of the Armstrong Sandpaper Abrasion Machine by F. M. Gavan, Armstrong Cork Co.

A Machine for the Evaluation of High-Temperature Alloys Under Combined Static and Dynamic Stresses by P. E. Hawkes and C. H. Ek, General Motors Corp.

Analysis of Commercial Sodium Tripolyphosphate by Reverse Flow Ion Exchange Chromatography by R. H. Kolloff, Monsanto Chemical Co.

Resin-Glass Bond Characteristics by F. J. McGarry, Massachusetts Institute of Technology

False Negative Permanent Strains Observed with Resistance Wire Strain Gages by C. J. Newton, National Bureau of Standards

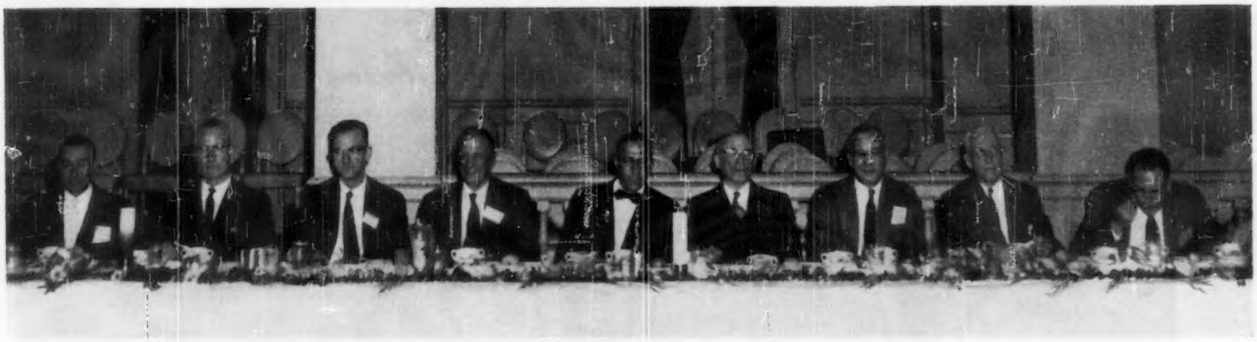
Measurement of Bulk Modulus of Hydraulic Fluids by R. L. Peeler and J. Green, California Research Corp.

A Method of Test for Potential Efflorescence of Masonry Mortar by P. L. Rogers, Riverton Lime and Stone Co.

Accelerated Aging Tests and Life Aging Properties of Aircraft Metal Adhesives by J. P. Thomas, Convair

An Instrument for the Measurement of Pore-Size Distribution by Mercury Penetration by N. W. Winslow, Prado Laboratories, and J. J. Shapiro, Land-Air, Inc.

Suitability of Lightweight Aggregate to the Manufacture of Bituminous Plant Mix by J. C. Wycoff, Southern Lightweight Aggregate Corp.



(See story below)

J. E. Gray, engineering director, National Crushed Stone Assn., chairman, Washington, D.C., District, ASTM; John Dunn, head of the Standards Branch, Department of Defense; John Green, director, Office of Technical Services, Department of Commerce; L. J. Markwardt, assistant director, Forest Products Laboratory, past-president, ASTM; R. W. Seniff, manager of research, Baltimore & Ohio Railroad Co., chairman, Study Committee for Technical Committee Activities, ASTM, national director, ASTM; A. T. Goldbeck, engineering consultant, National Crushed Stone Assn., chairman, Long-Range Planning Committee on Standardization Procedure, ASTM; honorary member, ASTM; Paul K. Miller, deputy director, Standardization Division, Federal Supply Services, General Services Administration; F. H. Jackson, consulting engineer, honorary member, ASTM, long-time principal engineer of tests, Bureau of Public Roads; and J. R. Dise, materials engineer, Cement Reference Laboratory, National Bureau of Standards, secretary, Washington, D. C., District, ASTM, technical assistant, ASTM Committee C-1 on Cement.

Newly Elected District Councilors and Guests Meet at a Dinner of the Central New York District

Among those present were: (left to right, above) Past President R. A. Schatzel; V. L. Parsegian, dean of engineering, Rensselaer Polytechnic Institute; G. H. Harnden, chairman, Central New York District; R. G. Folsom, president, Rensselaer Polytechnic Institute; K. B. Woods, president, American Society for Testing Materials; (below) E. J. Kilcawley, head of the Division of Soil Mechanics and Environmental Engineering, Rensselaer Polytechnic Institute; R. J. Painter, executive secretary, American Society for Testing Materials; G. D. Gunther, president, Mohawk Valley Technical Institute; L. B. Combs, dean of civil engineering, Rensselaer Polytechnic Institute; Past President T. S. Fuller.

CENTRAL NEW YORK

President Woods Speaks at Inaugural Meeting

The inaugural meeting of the Central New York District was held Monday, November 17, on the campus of Rensselaer Polytechnic Institute in Troy, N. Y. George H. Harnden, newly elected chairman of the district, presided at the session.

The main event of the evening was a talk by Prof. K. B. Woods, president of ASTM. In a well-illustrated discussion he described, "Polar Construction" (see New England District story, p. 19). Many interesting geological features of the Arctic and Sub-arctic were visually and orally described and the difficulty of building in this terrain outlined.

Introductory remarks for the meeting were made by Prof. E. J. Kilcawley, head, Division of Soil Mechanics and Environmental Engineering, Rensselaer Polytechnic Institute. The more than 125 in attendance were welcomed to the campus by Dr. R. J. Folsom, President of Rensselaer. Robert J. Painter, Executive Secretary of the Society acknowledged the greetings and reviewed ASTM's deep interest in engineering education for students, particularly in the field of materials.

ISO 61 on Plastics

Progress Reported at Washington Meeting

Gordon Kline, chairman of ISO 61, presides at opening plenary session. Others shown at right are ISO Vice-President George Hussey, ISO Secretary Henry St. Leger and the secretariat, C. L. Condit, and interpreters.

TECHNICAL Committee 61 on Plastics of the International Organization for Standardization held its eighth meeting in Washington on November 3 to 8 with fifty-six delegates from 12 countries participating.

The eight working groups considered approximately 35 of the items currently listed on the program of work in 14 sessions.

The Draft ISO Recommendation list of nearly 800 equivalent terms in five languages was revised in accordance with comments received. It will be submitted to the General Secretariat for approval and publication as an ISO Recommendation.

Five new Draft ISO Recommendations were approved and will be submitted to the General Secretariat for distribution to the ISO member bodies.

- Standard Atmospheres for Conditioning and Testing Plastic Materials
- Melt Flow Index of Polyethylene and of Polyethylene Compounds
- Recommended Practice for Compression Molding Test Specimens of Thermoplastic Materials
- Recommended Practice for Compression Molding Test Specimens of Thermosetting Materials
- Recommended Practice for Injection Molding Test Specimens of Thermoplastic Materials

Six Draft ISO Proposals were approved for formal letter ballot consideration of the Committee.

- Tensile Properties of Plastics
- Testing of Plastics with the Torsion Pendulum
- Determination of the Viscosity Number of Polyamide Resins in Solutions
- Determination of Acetone Soluble Matter of Phenolic Molding Materials
- Method of Test for Tracking under Moist Conditions
- Vicat Softening Point

Comparison of the above eleven items with ASTM plastics standards will show that many were based upon the ASTM standards.

Resolutions were adopted requesting the Atmospheric Testing Coordinating Committee (ISO/ATCO) to prepare a document on Methods of Measurement and Control of Relative Humidity in Large and Small Enclosures.

The committee organized a new working group to deal with specifications for the identification and quality control of plastic materials, and plans to consult with ISO Technical Committee 45 on Rubber regarding standardization activity on cellular materials.

The invitation of Germany to hold the ninth meeting in Munich, October 26–31, 1959, was accepted.

Technical Committee Notes

Metallic Materials for Electrical Resistance, Etc.

Non-Metallics to Be Added to B-4 Scope

For more than 25 years Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts has provided a place for consideration by the Society of electrical resistance and heating materials, as well as contacts and thermostat metals. As one of the B Group on Non-Ferrous Metals the interests of the committee have been confined for the most part to the metals field. With the increasing industrial applications of such non-metallic heating materials as molybdenum disilicide and silicon carbide it has become evident that the scope of the committee should be expanded to cover them. Accordingly at its meeting in Chicago on October 24, the committee voted to eliminate the word "metallic" from its title and to change its scope to cover non-metallic materials as well. This recommendation is being submitted to the Board of Directors for consideration at its meeting in January.

Contact Noise Problems Aired

Dimitry Grabbe of Photocircuits Corp. addressed the subcommittee on contacts, presenting the results of a research program which revealed new findings on the causes and means for reducing electrical noise in contacts. According to Mr. Grabbe, the primary source of electrical noise is mechanical in origin and is attributed to a number of factors including uneven contact pressure, bounce, etc. Mr. Grabbe presented evidence to show that contact material consisting of multi-strand wire provides good contact with greatly reduced noise. The explanation was that each tiny wire having different length and pressure on the contact, each resonating at a different frequency, provides a higher probability of contact. That is, the ratio of real-to-apparent contact area is more favorable and this results in lower contact resistance. Mr. Grabbe indicated that this type of contact is compatible with the objectives of long life, lower contact resistance, low noise, and low cost.

The committee completed its slate of officers by electing A. Mayeron, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., as vice-chairman of the committee. The other officers are: E. I. Shobert II, Stackpole Carbon Co., St. Marys, Pa., chairman; E. K. Strobel, Westinghouse Research Laboratories, Pittsburgh, Pa., secretary; and C. L. Guettel, Driver-Harris Co., Harrison, N. J., assistant secretary.

Electrodeposited Metallic Coatings

Magnetic Thickness Gages Being Evaluated

The completed portion of an extensive program to determine the accuracy and precision of the Method of Test for Local Thickness of Electrodeposited Coatings (A 219) was reported upon at the meetings of Committee B-8 on Electrodeposited Metallic Coatings held in Columbus, Ohio, on October 21–23. The preliminary reports from four cooperating laboratories indicate significant interlaboratory differences on all methods of thickness measurement for almost all coatings; the differences between methods are also almost always significant for all coatings, when comparing one type of magnetic thickness gage against stripping and microscopic methods.

A similar program is under way to evaluate three other magnetic thickness gages. The American Electroplaters' Society is cooperating in this study.

A new atmospheric exposure program to evaluate the corrosion resistance of electroplated copper, nickel, and chromium coatings on aluminum alloys is being assembled and is expected to begin in the spring of 1959.

All data from the atmospheric exposure studies of copper-nickel-chromium, and nickel-chromium in Programs 3 and 4 will be summarized in the 1959 Annual Report of the committee.

A monograph on electroless nickel which has been in preparation for 2 years is almost complete, and publication is anticipated in the spring. This publication will add a significant body of information to the field.

The new proposed standards reviewed were: a specification for heavy nickel and chromium coatings on steel, drafted to supersede the present maximum values in Specification A 166, and a recommended practice for preparation of nickel for electroplating with nickel.

Thermal Insulating Materials

Performance Standards Considered

Interest in the development of standards for thermal insulating materials continues unabated as indicated by the attendance—96 members and visitors, the largest on record—at the fall meeting of Committee C-16 on Thermal Insulating Materials held at Madison, Wis., on October 13 to 15. The development of performance, rather than composition, specifications was discussed. A special task group has been appointed by the Executive subcommittee to study the proposal that (1) all materials competing for the same market should meet the same specification requirements; (2) specifications should be written on the basis of performance rather than composition; and (3) the demand for materials specifications should come from consumers and not from producers. The subject of proprietary type standards will be related to this proposal.

An addition to the existing group of materials specifications—Specification for Amosite Asbestos Insulation for Pipes—was approved for letter ballot pending the report of the special task group mentioned above. A Specification for Reflective Sheet for Insulation was also approved for letter ballot, as well as a set of definitions relating to this type of insulation. The definitions will be recommended for inclusion in the existing standard C 168.

The evaluation of mechanical stability and emissivity—two important properties of thermal insulation—will now be covered by standard methods of test to be presented to the Society for approval. The mechanical stability method involves a tumbling action as a means of determining the handleability of preformed thermal insulation.

Also ready for presentation to the Society is a proposed Recommended Practice for Prefabrication or Field Fabrication of Thermal Insulating Fitting Covers. This standard will have as reference material an extensive set of tables providing dimensional standards which will be published as a separate document.

An interesting tour of the Forest Products Laboratory was included in the schedule, with the annual Get-Together Dinner being held on the evening of October 14. Due to the resignation of Chairman W. L. Gantz, a special election was held which resulted in the elevation of the former First Vice-Chairman W. C. Lewis, Forest Products Laboratory, to the chairmanship, and the election of J. R. Allen, Du Pont Co., formerly assistant secretary, as first vice-chairman. A new-

comer in the group of officers is J. R. Bridgeman, Public Service Electric and Gas Co., who was elected as assistant secretary. The next meeting of the committee will be held during ASTM Committee Week in Pittsburgh, Pa., the week of February 2.

Acoustical Materials

Evaluating Fire Resistance

Fire resistance properties of acoustical materials are the subject of a research program sponsored by Committee C-20 on Acoustical Materials, which met at ASTM Headquarters on September 25. This program, underwritten by the acoustical materials industry, will establish the reproducibility between laboratories of the test method (E 84–50 T), commonly known as the "tunnel test," used for the determination of fire hazard characteristics of interior finish materials. Four testing installations, located in this country and Canada, are participating in a round-robin test program. If the test shows good reproducibility, the committee will consider submitting it as a standard for the evaluation of acoustical materials. Meanwhile, a subcommittee is considering a modified panel test method, described in Federal Specifications SS-A-118a, and a radiant panel type of flame spread test.

Standards are needed for mechanical suspension systems, which have increased in use and variety of composition and are closely associated with acoustical materials. There are several critical properties requiring test methods, including sag, load-carrying capacity and corrosion resistance. It is hoped to interest both manufacturer and consumer representatives of these materials to participate on the committee. Among the consumer interests, building code industries have a definite interest.

Since painting has a deleterious effect on sound absorption efficiency of acoustical materials, the committee has renewed its efforts in the development of a test method for repaintability of acoustical materials. This method will include definite recommended procedures for application of paint and a means of controlling the amount required to produce a satisfactory coating and still retain good sound absorption.

With the acceptance by the Society of the reverberation chamber method of measuring sound absorption (C 423–58 T) and the adoption as standard of the impedance tube method (C 384–58), the coverage with respect to large-scale tests is complete. However, continued efforts are planned to develop small-scale and field test methods of measuring sound absorption. The horn coupler method is being developed, and a method known as the box method will be described in the ASTM BULLETIN. Methods for measuring sound absorption of acoustical materials in place will be investigated, with a task group being appointed for this purpose. Another phase of this activity is the correlation of small-scale tests with the reverberation chamber test.

Selecting the proper instrument for use in a light reflectance test method has presented problems. Attention has been focused on the Baumgartner sphere reflectometer. A proposed Method of Test for Measuring Air-Flow Resistance, published in the ASTM BULLETIN as information (January, 1956, page 29), will now be reviewed for consideration as a new tentative method.

The new officers of Committee C-20 are R. N. Hamme, Geiger & Hamme, Ann Arbor, Mich., chairman; H. J. Sabine, Celotex Corp., vice-chairman; and Ralph Huntley, Armour Research Foundation, secretary. The committee will hold its next meeting on April 16 in Chicago.

Structural Sandwich Constructions

Exposure Test Program

Since sandwich construction is a relatively new material, the question of durability and service life is of primary interest to the users of this type of construction, namely, the aircraft and building construction industries. Committee C-19 on Structural Sandwich Constructions has attempted to develop information by utilizing the ASTM test sites sponsored by the Advisory Committee on Corrosion. It was announced at the fall meeting of Committee C-19, held at The Martin Company plant, Baltimore, Md., on October 21 and 22, that a third exposure program, entitled Gamma, will be started next April using the ASTM test sites at Pennsylvania State University and at Kure Beach, N. C. A report covering the first exposure program is being prepared.

Progress continues in the development of test methods to evaluate sandwich constructions. The measurement of creep characteristics and creep rate of sandwich constructions loaded in flexure at any desired temperature is covered in a proposed method which was reviewed for letter ballot circulation to the committee. Two proposed methods for determining the resistance to peel of the bond between metal facings and core were reviewed and will be circulated to the committee for further action. One of these methods involves the use of the 4-in. diam hand or drum peel tester.

Symposium on Durability

The committee is planning to sponsor a Symposium on Durability and Service Life for Sandwich Construction at the Third Pacific Area National Meeting of ASTM in San Francisco the week of Oct. 11, 1959. With the members of the committee being scattered across the country, especially with a fair number of members, as well as other interested individuals located on the West Coast, consideration was given to the formation of a West Coast section. The members will be solicited to establish the interest and feasibility of such a plan and this will be discussed at the next meeting of the committee, planned for early spring in Dallas, Tex.

Concrete Pipe

Perforated pipe is finding increased use in construction and for general drainage purposes. A new specification for perforated concrete pipe will be added to the ASTM specifications on concrete pipe as a result of action taken at the annual meeting of Committee C-13 on Concrete Pipe held in Chicago on November 19–21. This specification will cover perforated non-reinforced concrete pipe intended to be used for underdrainage, with two classes, identified as standard strength and extra-strength pipe.

The committee has been concerned with the need for specifications to cover rubber-type gasket joints which are now used quite generally in the installation of concrete pipe. A good portion of the committee's attention was given to a final review of a proposed ASTM Specification for Flexible Watertight Rubber-Type Gasket Joints for Circular Concrete Sewer and Culvert Pipe, with approval being given for the circulation of this proposed specification to the committee for letter ballot. Factors considered in setting up the requirements include joint clearance, diameter tolerances of pipe joint, slope of the joint, limits of the load on the gasket, joint opening permitted, structural strength of the joint, joint length, joint lubricant, diameter tolerances permitted, and the concentricity of the joints. At present, this proposed specification is limited in its use to unreinforced concrete sewer pipe (C 14) and reinforced concrete culvert, storm drain, and sewer pipe (C 76T), where infiltration or exfiltration is a factor in the design.

Minor changes for immediate adoption were made in the Specification for Non-Reinforced Concrete Sewer Pipe (C 14), and small changes pertaining to steel areas and permissible variation were approved in the Specification for Reinforced Concrete Culvert, Storm

Drain, and Sewer Pipe (C 76T). A number of modifications in the Specification for Non-Reinforced Concrete Pipe for Irrigation and Drainage (C 118) will be submitted for immediate adoption. These changes will affect the physical test requirements with respect to values for minimum internal hydrostatic pressure and minimum three-edge bearing load as noted in Table I, allowable variation in diameter, and details of the test specimens and strength tests as well as the hydrostatic test. The Specification for Reinforced Concrete Low-Head Pressure Pipe (C 361) will have revisions in the sections dealing with concrete mixture; rubber gaskets; laps, welds, and spacing; curing of pipe; and preliminary tests.

With the acceptance of the new specification for rubber gaskets, it has been recommended that the Specification for Reinforced Concrete Low-Head, Internal Pressure Sewer Pipe (C 362) be withdrawn. This action is based on the fact that pipe made in accordance with Specifications C 14 and C 76 T and using the new rubber gasket joint will function more satisfactorily and will replace pipe made in accordance with Specification C 362.

A new subcommittee was authorized to review all methods of test which are now included with each specification for concrete pipe for the purpose of consolidating and unifying the test procedures in order that they may be published as a separate standard. This standard will accompany all specifications under its own designation.

Ceramic Whitewares

The translucency of fired whiteware materials is the latest in the group of fundamental properties for which a standard method of test has been prepared. This proposed method was approved for letter ballot at the meeting of Committee C-21 on Ceramic Whitewares and Related Products held in Bedford Springs, Pa., on September 25. The determination of the tensile strength of ceramic whitewares and allied materials is also being considered; but, due to the difficulty of establishing proper specimens, a questionnaire has been circulated to the members to determine the feasibility of such a method. It is still felt that the flexural strength test furnishes more significant information for ceramic whiteware materials.

New definitions covering additional raw materials, defects and processing were approved by the subcommittee and will now be sent to the entire committee for letter ballot. Development of standards for nonmetallic magnetic materials for microwave and computer applications are being processed.

In recognition of the activity in ceramic tile development, a new subcommittee was authorized to develop standards in this field. The policy of the committee is to establish working groups where activity in a particular industry warrants it.

Discussions were held on impact testing of ceramic whitewares using a modification of the Charpy impact test, a proposed test for alkali durability of glazed surfaces of ceramic whitewares, a method of test for solubility of lead from glazed surfaces, and a method for particle size analysis of whiteware clays by a hydrometer technique.

Electron Tube Materials

Lederer Outlines 35-Year Progress

BEFORE 1923, the only practical electron emitter used for vacuum tube cathode elements was thoriated tungsten. About 1924 to 1925, nickel was found to be a good cathode material, and this marked the beginning of the indirectly heated type of cathode element in electron tubes. Some of its early tubes made with indirectly heated cathodes were the UV 224, UV 227, and the 56, 57, and 58. These tubes, developed and used more than 30 years ago, may still be found in some old radios still in service. The point of special interest here is that E. A. Lederer, consultant, who recently retired from Westinghouse Electric Corp., and who developed these tubes back in the 20's, addressed ASTM Committee F-1 on Electron Tube Materials at its recent meetings at Skytop, Pa., in November. Dr. Lederer, from his experiences during his many years of tube development, told the members of the committee some of the things they would not find in books.

One of the early methods for coating cathodes was referred to as the vapor process. It used a tungsten cathode coated with tungsten and copper oxides. Barium azide was applied to the cathode and as the tube was evacuated, it was heated to 700 to 800 F, which decomposed the azide to form the oxide on the cathode. The released nitrogen was pumped out. While this process provided a very thin, but uniform, barium oxide coating, problems mainly associated with electrical leakages prevented it from being used commercially for very long.

Another interesting type of filament was the so-called cesiated tungsten filament. The problem of cesium deposition on the interior of the glass envelope was solved by coating the glass on the inside with a very high vapor pressure petroleum residue. Commercial application of the cesiated filament was prevented by the fact that at low temperatures the equilibrium of the tube was disturbed, and the filament did not emit sufficient electrons to function.

Dr. Lederer pointed out that, despite the great advances in semiconductor technology, the coated cathode tube is still the most important building block for electronic systems. Advances also are still being made in tube technology, as evidenced by development recently of cold cathode emitters and thermionic energy converters which provide a direct conversion of heat to electrical energy. He congratulated the ASTM committee for the most important contributions that had been made by any group to the understanding of cathode problems. He pointed out that the ASTM specifications for tube materials are well-known and widely used.

Technical Committee Notes

ASTM STANDARDS AT WORK

ASTM Underwater

SVERDRUP and Parcel, consulting engineers, are surveying the bottom of lower Chesapeake Bay in preparation for a possible bridge or tunnel.

While the work is slightly different from determining supporting values of subsurface materials for highways, ASTM procedures such as the "Thin-Walled Tube Sampling of Soils" and the "Penetration Test and Split Barrel Sampling of Soils" are still being widely applied. Description, classification, and logging of samples, as well as laboratory test procedures, also conform to ASTM methods.

To pinpoint the exact location of the drilling towers, Hastings-Raydist electronic navigation and tracking systems are being used, since conventional survey methods do not work out of sight of land. Sonar reflection equipment on the survey barge penetrates the subsurface materials several hundreds of feet to obtain "sonic reflections" for detecting different strata.

Reference Tubes Developed

At its meeting, Committee F-1 announced the completion of committee ballot on another proposed recommended practice employing a reference tube as a means of evaluating tube materials. This one describes a superclean planar diode, applicable to evaluation of materials for cathode ray tubes, and other similar tubes employing planar diode construction. Earlier, the committee had approved a recommended practice for testing tube materials using a reference triode which has been approved by the Society for publication as tentative. It describes the method for construction of multielectrode tubes which can be used for evaluating all types of tube materials. A third reference tube, a cylindrical diode, is described in Method F 270 which covers the test for relative thermionic emissive properties of cathode materials.

New Group on Cleaning

There is much interest in the electron tube industry in techniques for cleaning tube parts and for evaluating the degree of cleanliness of the parts, the air in assembly rooms, etc. This was evidenced at the recent symposium on cleaning, sponsored by the committee (see page 17). S. A. Standing, chairman of the committee, has appointed a task group to recommend the type of organization which might best function to develop the kind of standards needed by the industry. The establishment of a new group will probably take place at or following the Spring meeting of the committee.

Glass

Improving Sieve Analyses

The sieve analysis of raw materials used in the manufacture of glass must be very precise in order to estimate the particle size distribution of such materials as sand, soda-ash, limestone, alkali-alumina silicates, and other granular materials. To achieve this, Committee C-14 on Glass and Glass Products approved for letter ballot a proposed tentative method at its meeting on October 16, at Bedford Springs, Pa., held during the fall meeting of the Glass Division of the American Ceramic Society. To control the accuracy of the analysis, the proposed method requires standard matched sieves in addition to the usual set of standard sieves prescribed by ASTM. Further control and calibration of sieves is achieved by use of a master set of matched sieves.

A revision of the Method of Polariscopic Examination of Glass Containers (C 148) was approved for letter ballot of the committee. The purpose of the revision is twofold, to eliminate the need for standard disks, the supply of which has been depleted and the cost prohibiting further reproduction, and to clarify the interpretation of the significance of the results. A revision of the Method of Internal Pressure Test on Glass Containers (C 147) is being considered for further action of the committee. The committee plans to hold its next meeting in Chicago during the Annual Meeting of the American Ceramic Society.

Adhesives

Committee Rapidly Expanding

For 14 years D-14 Committee on Adhesives has exerted a powerful influence in promoting wider use of adhesives by developing universally acceptable methods of testing adhesives and adhesive bonding, by outlining gaps in present knowledge of adhesive properties, and suggesting approaches to fill these gaps by encouraging fundamental and engineering research on adhesvies, by initiating interlaboratory studies of new test methods, and by fostering the original Gordon Research Conferences on Adhesives.

This committee is expanding rapidly, reflecting the recent increased interest in industrial adhesives. On the horizon are standards for mastic adhesives and adhesives for acoustical tile, methods for measuring the effect of variations in glue-line thickness, the penetration of adhesives, and the tackiness of adhesives as well as atmospheric exposure service tests.

New subcommittees working on end-use standards for wood, metal, and plastic adhesives reported their progress at the Committee D-14 meeting held in Washington, D. C., on October 17.

The new subcommittee on wood adhesives is organized into two groups—East Coast and West Coast—to alleviate travel difficulties for the widely separated membership. Each group has the same general organizational structure and, since they function within the subcommittee, close cooperation is assured.

The chairman of the East Coast group, who is also chairman of the entire Subcommittee X on Wood Adhesives, is R. F. Blomquist, Forest Products Laboratory, Madison, Wis.

The chairman of the West Coast group is J. R. Ash, Monsanto Chemical Co., Seattle, Wash. Section chairmen are: *A* on Lumber Adhesives, W. H. Miles, Puget Sound Naval Shipyard, Bremerton, Wash.; *B* on Veneer Adhesives, P. L. Northcott, Forest Products Laboratory, Vancouver, B. C.; *C* on Pulp and Particle Board Binders, John Hine, Border Co., Seattle, Wash.; *D* on Special Problems, R. K. Stensrud, Reichhold Chemicals, Inc., Seattle, Wash., *E* on Assembly Adhesives (now inactive); *F* on Adhesives for Wood to Other Materials, T. E. Batey, Jr., Douglas Fir Plywood Assn., Tacoma, Wash.; *G* on Evaluation of Testing Techniques, J. E. Marian, University of California, Forest Products Laboratory, Richmond, Calif.

A similar arrangement is being organized for Subcommittee XI on Metal-to-Metal Adhesives.

For two years, engineering data have been gathered for an interlaboratory study to determine the effects of the rate of loading in the Method of Test for Strength Properties of Adhesives in Shear by Tension Loading (Metal to Metal) (D 1002-53 T). The study is now complete and the data will be published in an early issue of the ASTM BULLETIN.

Flexible Barrier Materials

The development of test methods on composite and laminated materials used as flexible barriers is receiving primary consideration by Committee F-2 on Flexible Barrier Materials as reported at its recent meeting held at the Edgewater Beach Hotel, Chicago, Ill., on October 15. Very encouraging progress was noted by the committee, which is one of the new committees of the Society, having been organized in December, 1957. Task groups have been appointed and have started the development of test methods for seal strength; tear, bursting, tensile, and impact strength; gas transmission; water vapor permeability; and moisture content. Preliminary work has consisted of the circulation of questionnaires and the review of existing test procedures.

The subcommittee on specifications is concerned initially with determining what should be included in a specification and what test methods will be required. This information will be referred to the subcommittee on test methods for its guidance. The subcommittee on nomenclature and definitions also met and their first project will be to establish definitions of such basic terms as flexible, barrier, material, and permeable. A liaison task group was appointed to work with Committee E-6 on Methods of Testing Building Constructions, as this committee is developing test methods for vapor barriers to be used under slabs.

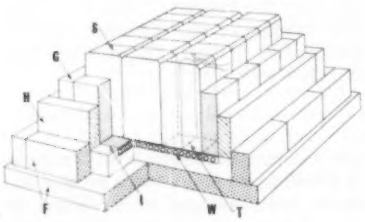
The next meeting of the committee is planned to be held in the spring in Chicago at the time of the meetings of the Packaging Division of the American Management Association.

Technical Committee Notes

Refractories

New Spalling Test Apparatus

A new hot-plate test for measuring the spalling characteristics of silica brick was reviewed at the 93rd meeting of Committee C-8 on Refractories held in Bedford Springs, October 1–2. This electrically-heated hot plate, shown below, was designed to provide a test more in keeping with the actual spalling characteristics and provides a convenient laboratory method of testing the ability of the brick to stand heat shock without chipping.



Spalling test hot plate.

The hot plate is composed of No. 15 gage resistance wire, *W*; 8 strips of Inconel sheet, *I*, covering a heating area of 24 by 24 in.; 5 thermocouples, one shown at *T*; 18 test specimen brick, *S*; and the unit surrounded by 9-in. silica guard brick, *G*, insulating block, *H*, and insulating fire brick, *F*. Heating rates from 140 to 1000 F per hour to reach 1470 F are specified with controlled cooling rates of at least 50 per cent of the heating rate.

A new method for determining the thermal conductivity of plastic refractories was approved for ballot. This method is similar to the recently published Method of Determining the Thermal Conductivity of Castable Refractories (C 417 – 58 T).

Standards in various stages of completion include: Specifications for steel pouring pit refractories; specification for insulating fire brick for linings in industrial furnaces for use in neutral or oxidizing atmospheres; a method of determining the gaseous permeability of carbon refractory material; a method of measuring size and bulk density of insulating fire brick; and a method of determining the resistance to hydration of basic brick, magnesite grains, and dolomite grains.

Three new load test schedules are being studied to replace schedule 5 in the Method of Testing Refractory Brick Under Load at High Temperatures (C 16 – 49). These new schedules are intended to obtain more informative engineering data for special and basic refractories at higher temperatures than covered by the present method.

Leather

Shoes, Sports Cars, Nuclear Subs—All Use Leather

Leather upholstery is used in many sports type automobiles and convertibles, and in order to make these leathers as durable as possible for this rather stringent application, the leather producers are cooperating with General Motors Corp. in an extensive outdoor weathering test to be conducted at the GM South Florida test site. The test will involve 2808 specimens of four different types of leather in three different colors. Six exposure periods for the test will enable determination of differences for exposures at various times of the year. A number of laboratory exposure tests will provide data toward correlation with outdoor weathering exposure. Altogether 14 laboratories are participating in this investigation, which is being conducted under the aegis of the Committee on leather, jointly sponsored by the ASTM and the American Leather Chemists' Assn. Progress on this exposure test and other active programs toward development of standards was reported at a meeting of the committee, held November 13 and 14, in Philadelphia.

Nuclear Sub Uses Leather Packings

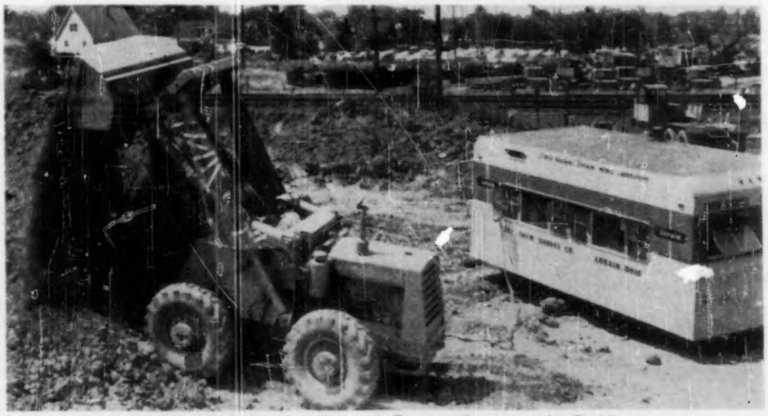
According to *The Houghton Line*, rubber impregnated leather packings have been found superior to other types of packing for the hydraulic systems, including the steering and dive controls in *The Nautilus*, which recently made a spectacular trip under the north polar ice. Development of tests for mechanical leathers is a going activity in the Joint Committee on Leather in a section chairmaned by A. N. Compton of E. F. Houghton and Co. This group developed the Tentative Method of Test for Corrosion Produced by Leather in Contact with Metal (D 1611 – 58 T) an important consideration in the use of leather in hydraulic systems.

Water Absorption Tests

Development is about complete on a method for static water absorption as well as alternative dynamic methods for measuring initial water penetration on shoe upper leather. The committee is studying a similar method for measuring initial water penetration of finished shoes, particularly those with vulcanized bottoms. Another method for initial water penetration covering glove leather is being evaluated in interlaboratory tests. Several other interlaboratory tests are in progress, covering water absorption and water repellency of garment leather and initial penetration of heavy leather.

Correlation of Test Data with Comfort

Correlation of subjective and objective data on leather has occupied the attention of many people for a long time. The committee decided that before any notable progress could be made it would be necessary to have reliable test methods which would measure properties thought to have a bearing on comfort. Accordingly the committee agreed to start work to develop test for the following: moisture-vapor absorption heat conductivity, cycling stress-strain characteristics, resiliency, electrical conductivity, and heat of wetting.



Mobile Laboratory Records Dyamic Strains in the Field

Trailer at right contains static strain indicator, as well as 12-channel oscillograph for recording dynamic strains. Bonded wire strain gages installed on loader at left give instantaneous strain readings under actual service conditions. Designed and equipped by The Thew Shovel Co., Lorain, Ohio, the mobile stress analysis laboratory is believed to be unique among manufacturers of excavating and lifting equipment.

Sorptive Mineral Materials

Sampling, sieve analysis, free moisture, and loss on ignition of sorptive mineral materials represent the first coverage by standards which were approved at the fall meeting of Committee C-23 on Sorptive Mineral Materials. This new committee in the Society has made great strides in preparing standard test methods within its scope. The committee met in Detroit on October 16 and 17 at the Hotel Statler. In addition to these four items, a number of other proposed methods are in varying stages of development, including bulk density, absorptive properties, solubility in water, resistance to breakdown in oil, dustiness, slipperiness, resistance to breakdown in water, and fire resistance.

An important development in the committee is in the activation of a new subcommittee on performance standards. It is evident that such type of standards will be very valuable in this field of materials. The general objectives established were (1) to develop plant evaluation methods of sorptive mineral materials, and (2) use these procedures to verify laboratory test methods established by the subcommittee on methods of sampling and testing.

It is felt that the committee can be of greater service to the industry in recommending detailed plant testing procedure which would include methods of application, length of time and contact, method of removal, and some objective means of evaluating effectiveness.

Officers for the ensuing two-year term were elected with A. R. Balden, Chrysler Corp., as chairman; L. M. Mank, Minerals and Chemicals Corporation of America, as vice-chairman; and R. L. Shirley, The Eagle-Picher Co., as secretary. Two members-at-large elected to the Advisory Committee were J. S. Aarons, National Tube Division, U. S. Steel Corp., and E. W. Coogan, Waverly Petroleum Products Co. A plant tour of the Trenton Engine Plant of the Chrysler Corp. was a most pleasant and informative part of the meeting program. The next meeting of the committee will be held in New York, N. Y., in the spring at a date still to be set.

World's Largest "Testing Machine"

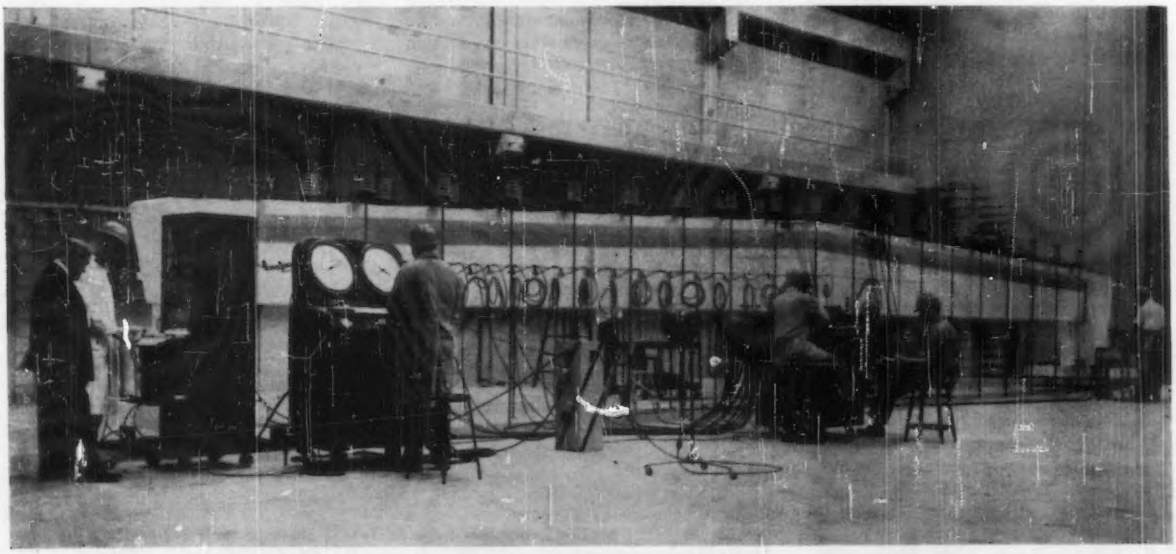
The world's largest "testing machine" has been erected by the Portland Cement Assn. at its laboratories in Skokie, Ill. The new three-story laboratory, instead of housing a testing machine, is itself a machine capable of exerting forces greater than 10 million lb.

The laboratory test floor, 56 by 120 ft, is a hollow concrete box girder, pierced by 690 holes on 3-ft centers, by means of which specimens can be held and loads can be applied. A top slab 24 in. thick and a bottom slab 18 in. thick are joined by webs to form the 12-ft deep box girder. Above the first floor, the entire building is assembled from precast concrete elements. Minimum concrete strength was specified to be 5000 psi at 28 days; reinforcing was rolled from alloy steel having a minimum yield point of 70,000 psi.

Loads are produced by hydraulic jacks, and load measurement is by oil pressure. Reactions (moments, forces, shears) are measured by electronic load cells. Readings from mechanical and electric strain gages are fed to hand-operated strain indicators or automatic recorders.

Structural elements as large as full-size floor slabs or roof shells can be loaded to destruction. A slab specimen can be subjected to local loads as high as 30,000 lb per sq ft. A slab the size of the entire test floor can be subjected to several thousand lb per sq ft over its entire area. Some of the problems now being studied are: methods of achieving continuity between prestressed members, repeated loading of prestressed girders, and the use of high-strength reinforcement without prestressing.

The laboratory is supervised by Dr. Eivind Hognestad, under the direction of Douglas McHenry, Director of Development. The staff includes 10 engineers and 10 technicians. Vice-president for research and development of the Portland Cement Assn. is Dr. A. Allan Bates, ASTM vice-president.



A 60-ft Girder Under Test in the Portland Cement Assn's New Structural Laboratory.

Test forces are applied through steel rods, which can be seen extending from cross pieces over the girders down through holes in the floor. Under the floor are hydraulic jacks which pull down on the rods. This beam was later broken under a total load of 360,000 lb.

Electrical Insulating Materials

Von Hippel Defines Intrinsic Dielectric Breakdown

Those who heard Prof. A. R. von Hippel of Massachusetts Institute of Technology at the Philadelphia meetings of Committee D-9 were provided a new look at dielectric breakdown phenomena. The occasion was a Symposium on Factors Affecting Dielectric Measurements, held Wednesday evening, October 29. Professor von Hippel urged efforts toward understanding of each other's point of view by engineers and scientists in the field of electrical insulation. Expressing the scientists' view that one should attempt to explain phenomena on a molecular level, he pointed out that empirical tests often reveal little about the inherent properties of the material, but they do enable discovery of defects due to processing. Using, as an illustration, dielectric breakdown measurements on a large number of plastic film specimens, he showed that there is a double peak in breakdown values, with a portion of the specimens breaking down at a much lower value than the majority of specimens. This is indicative of faults in the material and not of inherent properties in the material. When asked to define intrinsic breakdown, Professor von Hippel suggested that it might be considered "impact ionization breakdown in an undistorted field." It was evident to those present that both engineers and scientists may profit by a mutual exchange and understanding.

Also on the program for the symposium were J. S. Johnson of Westinghouse Electric Corp., who discussed the effect of electrode configuration, and W. T. Starr of General Electric Co., who discussed the effect of corona on breakdown measurements. George Sommerman, of Westinghouse Electric Corp., presented information on the recent meetings of IEC 15 on electrical insulation, held in Sweden.

New Committee on Liquid and Gaseous Insulation Recommended

Consideration of a recommendation from Subcommittee IV on Liquid Insulation that a separate technical committee be established with that group as the nucleus was finalized when the Advisory Committee of D-9 on Electrical Insulating Materials approved the recommendation for presentation to the ASTM Board of Directors. The new committee would cover both gaseous and liquid dielectrics.

The Advancing Plastics Front

A Staff Interview with A. Polymer,[1] Director of Research, Large Molecules, Inc.

Q. Mr. Polymer, you have just attended the Philadelphia meetings of Committee D-20 on Plastics. What are your impressions?

A. Polymer.—As you know, developments in the plastics industry are moving so fast, it is hard to keep up with all of them. I am impressed that Committee D-20 is trying to do this.

Q. In what way?

A. At this meeting the committee established a new group to develop tests for crack propagation in plastics. Also a new section on ablation resistance was established.

Q. Ablation?

A. Yes, this is of interest in the aircraft and missiles industry. The word "ablation" means a wearing away or removal of material and the way it is used it refers to high-temperature applications in missiles such as for nose cones where reentry into the atmosphere is a problem.

Q. What other new activities are there?

A. The committee has also established a new subcommittee on plastic tooling. This is a cooperative effort with the American Society of Tool Engineers, the Society of Plastics Engineers, and the Society of the Plastics Industry, all pooling their efforts to develop plastics tooling standards. Mr. Joseph Mele of Grumman, who represents the Tool Engineers, has agreed to be chairman of this subcommittee.

Q. This is an impressive new activity. Are there others?

A. Yes, the committee has also set up a group to develop standards for vinyl plastic dispersions. This is cooperative with the Society of the Plastics Industry. Another omen of new things to come is that the section on polyethylene was renamed the section on polyolefins. This, of course, leaves the way open to the development of standards for polypropylene and other isotactic and atactic polymers so much in the news recently.

Q. We often hear about confusion concerning the meaning of various tests for plastics, that is, how the results are to be interpreted and what they mean in terms of specifications, design, etc. Is the committee doing anything about this?

A. Yes indeed, two things as a matter of fact. A task group headed by A. C. Webber has just completed a guide to writing specifications for plastics. After approval by the committee this guide will be published by the Society. The other thing the committee is doing to clarify some misconceptions about plastics testing concerns a decision to prepare for publication a manual on plastics testing. Chairman Reinhart has appointed a task group to recommend a procedure for preparation of the manual.

Q. What has been said so far concerns new activities. What about completed work?

A. There is a good deal of that too, and I might mention a few new items which are either being balloted on in the committee or have been approved as tentative. These include a new method for heat distortion temperature of plastic films, a recommended practice for carbon arc type exposure apparatus, a specification for flexible polyethylene pipe, and methods of test for compressive strength, tensile properties and apparent density of rigid cellular materials.

Q. It seems to me that there were a large number of visitors at this meeting. Would you comment on that?

A. The committee was host this year to the international delegates to the ISO 61 Committee on Plastics, which met in Washington early in November, the week after the ASTM committee meetings. Some 31 ISO delegates, mostly from European countries, attended the plastics committee meetings and were able to see how our committees operate. Needless to say, the delegates were most welcome.

Q. Thanks very much Mr. Polymer; May we quote you?

A. Certainly.

[1] Any resemblance to an actual person is purely unintentional.

Aerial View of Four of the Six Test Loops of the AASHO Test Road
Test Vehicles are parked in the turn-around

AASHO Road Test

THE scientific, engineering, military, and political fields were all represented at ceremonies marking the start of traffic at the AASHO Road Test, Ottawa, Ill., October 15.

Sixty trucks started rolling over the test pavements. They will run 18 hours a day, six days a week for two years. Drivers will be troops from the U. S. Army Transportation Corps Road Test Support Activity, a 300-man force stationed at the test site.

This huge project is sponsored by the American Association of State Highway Officials (AASHO) and is administered and directed by the Highway Research Board of the National Academy of Sciences-National Research Council. ASTM President K. B. Woods has been closely associated with this project since its inception, as a member of the executive committee and (chairman in 1956 of the Highway Research Board.

The test pavements, both concrete and asphalt, are built in a wide range of thicknesses, Test vehicles range from pick-up size with 2000-lb loads on single axles up to huge tractor-semitrailers with 48,000 lb on tandem axles.

The objectives are: (1) to determine the significant relationships between the number of repetitions of specified axle loads of different magnitude and arrangement and the performance of different thicknesses of uniformly designed and constructed asphaltic concrete, plain portland-cement concrete, and reinforced portland-cement concrete surfaces on different thicknesses of bases and sub-bases when on a basement soil of known characteristics; (2) to determine the significant effects of specified vehicle axle loads and gross vehicle loads on bridges of known design and characteristics; (3) to make special studies dealing with such subjects as paved shoulders, base types, pavement fatigue, tire size and pressures, and heavy military vehicles, and to correlate the findings of these special studies with the results of the basic research; (4) to provide a record of the type and extent of effort and materials required to keep each of the test sections or portions thereof in a satisfactory condition until discontinued for test purposes; and (5) to develop instrumentation, test procedures, data, charts, graphs, and formulas, which will reflect the capabilities of the various test sections, and which will be helpful in future highway design, in the evaluation of the load-carrying capabilities of existing highways and in determining the most promising areas for further highway research.

During the two-year traffic period, scientists, engineers and technicians from the Highway Research Board's test road staff will record millions of pieces of data on the behavior of the pavements under traffic. More than a million dollars worth of electronic and mechanical instruments—many developed specially for the project—will be in use.

The test is a scientifically-designed experiment and is by far the largest and most comprehensive test of its type ever undertaken. Its findings are expected to influence future highway design and construction and to be valuable in studies being made by other agencies on vehicle sizes and weights and highway cost allocation.

International Symposium on

Plastics Testing and Standardization

A VERY significant exchange of information in the field of plastics occurred in Philadelphia on October 30–31, at the Symposium on Plastics Testing and Standardization, sponsored by the Society, on behalf of the American Group for ISO 61. About four-fifths of the papers were presented by speakers from countries other than the U. S. and which are represented on the International Standards Organization Committee 61 on Plastics, which met in Washington the following week.

The first session on national standardization was introduced by Admiral G. F. Hussey, Jr., managing director of the American Standards Assn. and vice-president of the ISO. Participants were from Germany, Hungary, The Netherlands, Poland, Sweden, United Kingdom, and U. S.

The second session was devoted to methods of test for engineering properties of plastics. Included were papers from Prof. M. P. Dubois of France, Dr. Hilding Hogberg of Sweden, Dr. G. de Senarclens of Switzerland, and H. Warburton Hall of England.

The third session was devoted to thermal properties of plastics, with papers from Germany, England, France, and U. S.

Methods for molecular characterization was the subject of the fourth session with three papers, all by authors from the U. S., covering dilute solution properties of polymers, infrared spectroscopy and X-ray diffraction and scattering for determining polymer structure, and nuclear magnetic resonance as a means for studying polymer chain flexibility.

The papers, together with their discussion, will be published by the Society as a *Special Technical Publication.*

Worldwide Advances in Plastics Theme of SPE Conference

IN A four-day meeting, January 27 to 30, in New York, the Society of Plastics Engineers will cover subjects ranging from mold design to ultra-high temperature applications, and from printed circuits to plastics in building.

Frank W. Reinhart, chairman of ASTM Committee D-20 on Plastics, will moderate a session on test methods where subjects will include hardness tests, stress cracking of ethylene plastics, and flammability tests.

Altogether, 100 papers will be presented in 26 technical sessions with many ASTM members participating.

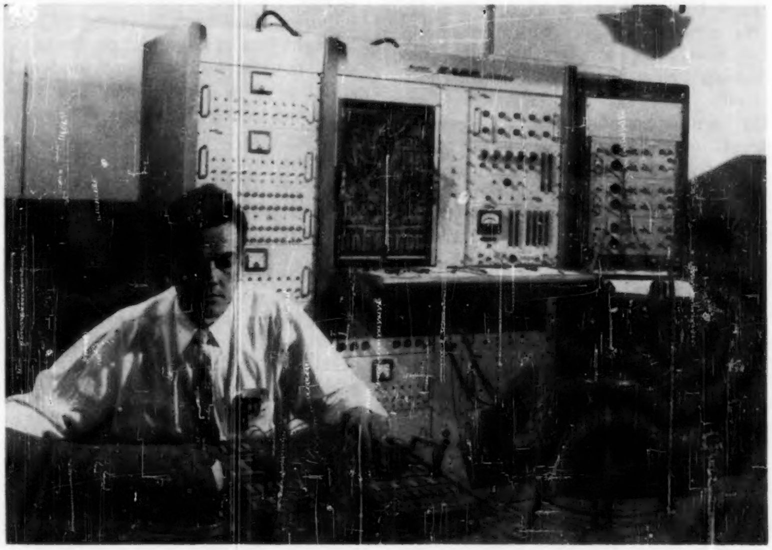
Instrumentation in the Space Age[1]

Henry P. Dever Traces Its Historic Roots

WHAT our engineers and scientists have created with their brains and skills—a whole host of modern marvels that range from electronic ovens and television to atomic energy and space vehicles—staggers the imagination, but it can be truly said that none of these things would have been possible without instrument.

Instruments are often called the tools of science, but they are not the scientist's special province alone. The dashboard of the automobile is full of instruments; thermometers of several varieties are commonplace, and the temperature control in the home or office involves several kinds of instruments in addition to the thermostat. Instrumentation touches our lives at almost every turn. I can think of no better example to drive this point home than that of the generation and distribution of electric power. When you flip a light switch on the wall you affect one of the most completely automated processes in the world. A vast array of less familiar instruments—some simple, many very, very complex—are widely used in laboratories, offices, and factories—yes, and even in homes and on the farm. They are growing in number and variety with every passing day, and new companies to make them have sprung up by the hundreds.

Instrumentation first began with measurement. One of the earliest industrial process variables to be measured was temperature. Sir Isaac Newton, in 1701, disclosed his method of measuring furnace temperature by cooling a red-hot iron bar. Eighty-one years later Josiah Wedgwood, the famous potter, developed the first practical system for measuring furnace temperature by observing the contraction and expansion of clay cylinders. Crude as this system was, it lasted for some 40 years until, in 1822, John Daniell introduced a pyrometer that operated on the principle of the expansion of a platinum rod. While Daniell's pyrometer was inaccurate in comparison with today's instruments, it nevertheless was the first device to provide a continuous reading without someone having to watch over it constantly. Some years later an English emigrant, Edward



An engineer programs a new setup, while the analog computer solves a differential equation.

Brown, developed the first pyrometer of American design. The device put together in his small Philadelphia workshop measured the difference in the expansion of iron in contrast to non-expanding graphite when the two materials were thrust into a furnace. His pyrometer mechanically multiplied this difference and indicated it with a pointer that moved over a dial graduated in degrees. Edward Brown and his son, Richard P. Brown, built this small workshop into the Brown Instruments Co., which became a part of Honeywell nearly a quarter of a century ago.

The next major advance in the evolution of instrumentation was that of recording, since the production of a record is often the principal objective of measurement where the need is to know exact performance over a period of time. Records may be needed as an operating guide for a manufacturing process—a check on performance that not only provides instantaneous information but also shows what trend exists, so that corrections may be made to regulate the process.

Once a process variable such as temperature, flow, pressure, frequency, density, and the like could be measured and recorded, the next logical development in the art of instrumentation was that of control. This is the concept of measuring the output of a process or system and feeding this intelligence back to control the input. The idea of automatic control is not new; human nature includes a strong urge to do what we must with the least effort. So it isn't surprising that mankind has used controllers of one kind or another for many years and that, industrially, automatic control has been around ever since James Watt invented the flyball governor to regulate the speed of his steam engine.

As long ago as 1784, Philadelphia was the scene of a noble experiment when Oliver Evans built and operated a continuous flour mill that was entirely automatic from receipt of the grain to milling of the flour. And in 1801, Joseph Jacquard exhibited an automatic loom controlled by punched cards similar to those used today by modern office equipment.

The most important and far-reaching advances in automatic control have come largely since the 1930's. Developments have come along so fast that the pace of trying to keep abreast of them has been a dizzying experience. They have been the inevitable solutions to problems caused by the increasing complexity of industrial processes and the need for greater production of a

[1] Abstracted from an address by Henry F. Dever, vice-president, Minneapolis-Honeywell Regulator Co., and president, Brown Instruments Division, Philadelphia, before the Rotary Club of Philadelphia, Sept. 10, 1958.

better, more uniform product at lower unit cost.

The age of electronics has been another factor responsible for this upsurge. Until the emergence of electronics, industrial instruments were either mechanical, hydraulic, pneumatic, or electrical. Many still are, and we have by no means consigned them to the scrap pile. But with the advent of electronics a new dimension was added. New vistas of accuracy, sensitivity, and speed were opened up. It became possible, with the development of the vacuum tube and more recently of transistors, to amplify electrical signals which, although capable of being measured, were previously too minute to be used in recording and control. Transmission of intelligence *via* electronics improved communication. Process data could now be dispatched to or from remote locations either over wires or by microwave radio. In the field of computation, electronics took up where the far slower mechanical calculating machines left off, giving us today's high-speed analog and digital computers.

In this century, the manpower shortages resulting from war intensified the need for instruments and machines to serve in place of men's eyes, hands, and brains. World War II greatly accelerated the pace of military instrument development. It brought with it radar, sonar, atomic energy, rockets, missiles, and many other items of wizardry that had been only a dream. Some of these accomplishments of the military, such as radar on ships and planes already have filtered down to civilian life.

Instrumentation long has been recognized as a major tool in the relentless efforts by management to cope with the rising costs, broadening complexity, and continually enlarging scope of industrial operations. In my opinion, it will play an even greater role in the years ahead because of the vast need—I might even say desperate need—for increased productivity.

Machine tools with more power, more speed, and more capabilities are being designed and developed all down the line. Some machines can now perform a variety of operations electronically, using instructions from punched cards or tape fed through a computer. Much of the burden in increasing productivity will fall heavily on such machinery and equipment, being made available as a result of new and improved technology.

It is an age of innovation and change, and those who face it with open minds and an intelligent willingness to surmount the problems that will inevitably arise will be the ones who reap the rewards.

Report to the Chemical Industry on

Status of D319 Cr-Ni-Mo Stainless Steel

The Project.—Since 1951 the ASA Chemical Industry Advisory Board (CIAB), in cooperation with the steel industry, has been striving to have brought into commercial production a new molybdenum-bearing austenitic stainless steel alloy. Over the years there had been an increasing demand by the chemical industry for special modifications of the AISI Type 316 alloy in an apparent effort to improve general corrosion resistance. Usually a higher chromium content was sought, but wide variations in the content of other elements also were in evidence. Since demands were not uniform, modifications of the standard analysis usually could not be obtained from warehouse stocks. Securing end products from selective or modified heats was attendant upon procurement delays.

The Solution.—The chemical industry was surveyed to establish requirements of Cr-Ni-Mo stainless steels, and sufficient demand from a substantial number of consumers, both large and small, for a new standard alloy became apparent. A special CIAB subcommittee working jointly with AISI Stainless Steel Technical Committees decided upon a producible alloy that would more generally conform to the indicated requirements. The chemical composition is as follows:

D319 STAINLESS STEEL—CHEMICAL COMPOSITION

Element	Per Cent
Carbon, max	0.07
Manganese, max	2.00
Silicon, max	1.00
Phosphorus, max	0.045
Sulfur, max	0.030
Chromium	17.50 to 19.50
Nickel	11.00 to 15.00
Molybdenum	2.25 to 3.00

The designation, "D319," was assigned by the American Iron and Steel Institute. It is known as a "development" alloy, and was so designated pending the making of a tonnage survey now scheduled for 1959. It was indicated by AISI that when sufficient demand develops, the new stainless steel would be designated "AISI Type 319."

Not Untried.—Many of the special modifications of Type 316 procured and used by the chemical industry fall within the analysis range of D319. Up to 15 years of service experience has been reported, and this experience is all good. Actually, then, D319 is not a new and untried alloy, but rather the result of an intense cooperative effort to make an alloy of improved characteristics and broader service utility readily available on a commercial basis.

Not a Cure-All.—Those responsible for the project suggest that users of Type 316 or special modifications thereof consider the use of D319 for corrosion resistance, avoidance of product contamination, and ultimate ease of procurement. Because of the many variations in process conditions, no blanket recommendations can be made for specific new service applications. Assurances for these should invariably be sought, through the individual company's own testing procedures.

Code-Approved.—Formal approval for the use of D319 in Code construction has been obtained through Special Ruling, Case No. 1254, issued by the Boiler and Pressure Vessel Committee of The American Society of Mechanical Engineers. This approval is covered by the following reply to the CIAB inquiry:

"September 2, 1958. *Reply:* It is the opinion of the Committee that a steel having a chemical composition as stated in the *inquiry* and designated D-319 may be used for Code construction under all the rules applicable to Type 316 stainless steel. The allowable stress values for the regular Type 316 shall apply. The qualification of Procedure and Performance in Section IX for Type 316 shall apply."

It Is Available Now.—Through inquiry by an individual chemical company it has been determined that substantially all of the principal stainless steel producers have stocks of D319 immediately available—some in ingot form; others in finished form, in both tonnage and reasonably minimum quantities.

Let's Use It.—Where Type 316 normally is used, D319 may offer improved general corrosion resistance. It's Code approved; it's available; let's use it!

J. G. Henderson, chairman,
ASA Chemical Industry
Advisory Board

Testing of Prestressing Materials and Concrete Control on the Northern Illinois Toll Highway*

By JOSEPH J. WADDELL

When the specifications and plans were being prepared for the Northern Illinois Toll Highway, the Toll Highway Commission and Consulting Engineer were agreed that high quality construction was a paramount objective. Petrographic tests of aggregates, finish screening of coarse aggregates and semiautomatic batching plants were all conducive to uniform, high quality concrete. Strength tests were analyzed statistically for control of the cement content and analysis of operations.

Production of prestressed concrete girders for over 200 bridges and prestressed, hollow concrete piles for 90-odd bridges, presented many problems in inspection and testing. Techniques had to be developed or modified for testing fabric pads for bridge bearings, making tension tests of 7-wire prestressing strand, control of stressing operations when both straight and deflected strands were used, and making compressive strength tests of zero slump concrete.

THROUGH northern Illinois there is now under construction a system of toll roads designed to relieve some of the traffic congestion in the Chicago area. These roads compose the Northern Illinois Toll Highway, consisting of 193 miles of 4 and 6-line limited access tollway.

Under the general supervision of Joseph K. Knoerle and Associates, Consulting Engineer, 26 section engineers and architect engineers supervise construction on nearly 100 construction and supply contracts. All off-site testing and inspection is being done by three commercial testing agencies under contract with the Toll Highway Commission, and all on-site work is performed by the section engineers. The consulting engineer exercises over-all control for the Commission, and performs inspection and testing of the prestressed concrete.

In general, materials control procedures follow standard methods on this project, but some changes have been necessary to keep up with the progressive tone of the specifications. Conventional requirements for concrete, for example, have been modified to include provisions such as:

Use of a petrographic test of aggregates, and inspection of structures in service, to aid in determining suitability of aggregate sources.

Finish screening of coarse aggregates at the batching plants to minimize variations and excesses in undersize.

Use of semiautomatic batching plants for all paving concrete and most structural concrete.

Statistical analysis of concrete strengths whereby the cement content may be raised or lowered, depending on the efficiency of operations.

In addition, the modern design adopted for 214 bridges includes the use of prestressed concrete girders, with 89 of the bridges supported on 36-in. hollow posttensioned concrete piles, introducing testing and control procedures of a type not heretofore performed on a large scale on any one job. It was realized that normal testing procedures would have to be modified for some phases of control of prestressed concrete, and several new techniques were therefore developed.

Among the questions that were raised, and for which there were no well-standardized procedures, were the following:

(*a*) How to make load-deflection tests of fabric pads for bridge girders,

(*b*) How to make tension tests of 7-wire prestressing strand,

(*c*) How to inspect and control stressing operations where both straight and deflected strands were used in pretensioned girders, and

(d) How to make compressive strength tests of zero slump concrete for posttensioned concrete piles.

Concrete Control

Special Requirements

Through the area covered by the tollway, more than 50 aggregate sources were proposed by contractors and were investigated by the consulting engineer. In the great majority of these there were no serious problems of quality. In a few, petrographic analysis revealed the danger of a possible mild alkali-aggregate reaction when high-alkali cement was to be used. Field examination of structures confirmed the fact that the reaction existed and that it was mild. In another case, the examination disclosed an excessive proportion of soft and unsound particles that was not evident in any of the usual physical tests. Beneficiation by means of impact crushing served to reduce the proportion of unsound particles to a tolerable amount in the latter case, and selective use of material sources was of value in both cases to permit use of different materials without compromising the desired quality. By use of the petrographic test, a warning sign had been raised, pointing out potential weaknesses or danger points and indicating the need for caution and further investigation.

Normal physical tests were also made, following standard ASTM methods. Besides furnishing important data on the quality of aggregates, those

NOTE:—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Sixty-first Annual Meeting of the Society, June 22–27, 1958.

JOSEPH J. WADDELL is Project Materials Engineer, for Joseph K. Knoerle and Associates, Inc., on the Northern Illinois Toll Highway Project, where he is in charge of inspection and control of all materials for the project. Prior to this assignment he held a similar position with Palmer & Baker on the Lake Pontchartrain Bridge and other works in Louisiana. He was employed by the Bureau of Reclamation for many years as a materials engineer, having served in that capacity at Parker, Friant, and Shasta Dams in California, as well as on other reclamation projects. He is a graduate of the University of Arizona and a registered Professional Engineer.

tests provided information that was necessary for proportioning concrete mixes, using the trial mix method of the American Concrete Inst.

Uniformity of Concrete

One objective of the specifications has been uniformity of concrete. Uniform high-quality concrete is desirable in itself and savings in the most expensive ingredient, cement, may be effected provided the quality is held at a level commensurate with what is required. Raw materials of constant quality leads to uniformity of concrete, and one way of eliminating variations in aggregate is to screen the coarse aggregate at the batching plant. Finish screening has served to improve uniformity in coarse aggregate at the batching plant in much the same way that uniformity is obtained at asphalt hot-mix plants, and aggregate uniformity has been conducive to greater uniformity of concrete quality.

As a further aid in obtaining uniform high-quality concrete, semiautomatic batching plants were specified for all paving concrete and for most structural concrete. In a batching plant serving two or more 34-E pavers, automation smoothed out the irregularities that would have occurred with manual operation, and also speeded up operations. On those sections where there was only a small amount of concrete construction, manual operation was permitted.

A semiautomatic batching plant was defined in the specifications as one in which batch weights are set manually, mixers (or batch trucks) are charged manually, materials are batched automatically, and batches are dumped from the weigh hopper under manual control. Automatic interlocks were provided to prevent irregularities in weighing and batching, and weigh hoppers were equipped with autographic recorders to provide a permanent record of operations. All batching plants were equipped with electric recording moisture meters in the sand hopper.

Field control of the concrete was accomplished by means of the usual tests—slump, air content, unit weight, and compressive strength. In addition, experimental use was made of a test to determine the cement content of fresh concrete. Two procedures were followed, one a simple wash test over a 200-mesh screen, and the other consisting of centrifuging and washing. It is too early to make any statement as to the value of the cement content test, as results to date are inconclusive. However, it is believed that eventually a test of this nature will become a part of concrete control. Such a test would be a step toward better concrete control by providing control at the batcher and mixer at the time the concrete is made instead of a month later as is the case when attempting to control concrete by means of the 28-day compressive strength test.[1]

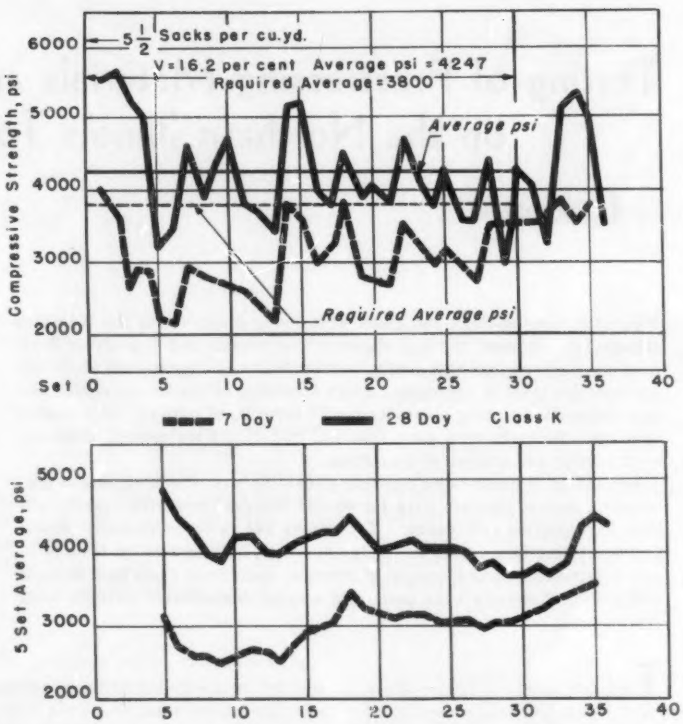


Fig. 1.—7 and 28-day compressive strength control charts.

Statistical Control

In order to evaluate the benefits of these measures for uniformity and to make it worth while to the contractor to assist in achieving this objective, a program of statistical analysis and control was set up whereby performance was analyzed at intervals.[2] On the basis of these analyses upward adjustments were made in the cement content when performance was poor and downward adjustments were made when performance was better than average. In the case of poor performance, it was usually possible to discover causes and correct them after the temporary expedient of an increased cement content had been used.

Analysis was accomplished by means of control charts (Fig. 1). Both 7 and 28-day compressive strengths were plotted on these charts which provided a day-to-day record of performance, showing values and trends by which performance could be analyzed.

TABLE I.—REQUIREMENTS FOR CONCRETE.

	Classes of Concrete			
	Pavement	Structural		
		K	M	R
Maximum size aggregate, in. (nominal)	2	2	1	1
Minimum cement content, sacks per cu yd [a]	5½	5	5¼	6¾
Maximum water-cement ratio gal per sack of cement	5½	5¾	5½	5
Maximum slump, machine finish, in.	1½	...	...	...
Maximum slump, hand finish, in.	3	...	...	...
Maximum slump, structures, in.	...	3	3	3
Entrained air, per cent of volume of concrete	4½ ± 1	4 ± 1	4 ± 1	3 ± 1
Required compressive strength at 28 days, psi	4000	3000	3000	5000

[a] The contractor shall use as much cement as needed to meet the requirements of the specifications without additional compensation.

[1] Tentative Method of Test for Compressive Strength of Molded Concrete Cylinders (C 39 – 56 T), 1956 Supplement to Book of ASTM Standards, Part 3, p. 190.

[2] "Evaluation of Compression Test Results of Field Concrete," Report of ACI Committee 214, *Journal*, Am. Concrete Inst., Vol. 27, No. 3, Nov., 1955, p. 241.

Requirements for the several classes of concrete are shown in Table I. On the basis of 6 by 12-in. cylinders, specifications for pavement concrete required that at least 80 per cent of the tests equal or exceed 4000 psi. Requirements for structural concrete were, that at least 90 per cent of the tests equal or exceed the specified 28-day compressive strength and that no more than three consecutive tests fall below the specified strength. A test was defined as the average of one set of one or more cylinders made at one time from the same batch. A probability table was included in the specifications for each class of concrete showing the average compressive strength that would be needed for different degrees of uniformity in order to meet the requirements of a specified maximum number of tests falling below the specified strength. Strengths shown in this table varied in accordance with the coefficient of variation, the more uniform and efficient jobs meeting the requirements with a lower average strength.

Prestressed Concrete

Pretensioned, prestressed concrete bridge girders were made throughout the year. There were four casting yards for this purpose, including one that was completely enclosed in a steel mill-type building. Lengths of beds ranged from 200 to 600 ft. In addition, girders for one bridge were posttensioned at the site, and hollow concrete piles for 89 bridges were posttensioned, separate plants having been erected for these purposes.

Pretensioned Bridge Girders

Methods of fabricating these members followed conventional methods of the industry. However, it must be remembered that the prestressed concrete industry has been growing rapidly and techniques are changing as more knowledge is gained. This is one reason why inspection and control procedures had to be flexible enough to meet changing conditions. Batching and mixing of concrete were controlled in the same way as the rest of the concrete on the project. Class R 5000 psi concrete, mixed in a semiautomatic plant, was specified, with 4000 psi specified to be developed before the prestressing force could be released.

The large amount of prestressed concrete required made it necessary to establish procedures for the control of materials and casting operations. An example was the control of stressing for both straight and deflected strands in pretensioned girders. In the case of straight strands, dual control was effected in the usual manner by observing (*a*) the wire elongation and (*b*) the load necessary to produce this elongation, as shown by the hydraulic pressure applied to jacks. Differences in tension indicated by the two methods were less than 5 per cent. Release of tension in the bed, for girders with straight strands only, was accomplished by merely releasing the jack pressure, which released all strands simultaneously.

In the case of deflected strands, complications arose both in tensioning and releasing. This was further complicated by the fact that the work was done in four different plants, all of them operating in a different manner. In general, the procedure was to use SR-4 strain gages generously during the early stages in each plant, attaching them at several points along a single strand at a time to determine the uniformity and accuracy of the tension along the length of the selected strand. These gages were attached to the loose strand in the form and observations were made before, during, and after stressing. Load cells were also used, these being attached under the grips at each end. Once the stressing arrangement was decided upon and approved, based on the uniformity of distribution of stress in the strand as indicated by the strain gages, no further changes were made, and the load cells were used for control, together with observation of elongation and jack pressure.

Curing and release of stress were both under close scrutiny, especially when it was discovered that there was a relationship between curing, release of tension in the deflected strands, and the formation of vertical cracks in the girders, between the hold-downs. To prevent these cracks, a procedure was adopted at all plants which provided that, after placement of the concrete in the forms, concrete temperature was maintained above 50 F and below 80 F for about 4 hr after which steaming was started, the temperature being raised in the enclosure to 140 F in 3 to 4 hr. Field-cured cylinders, steamed with the girders, showed when the required 4000 psi compressive strength was reached, at this point the

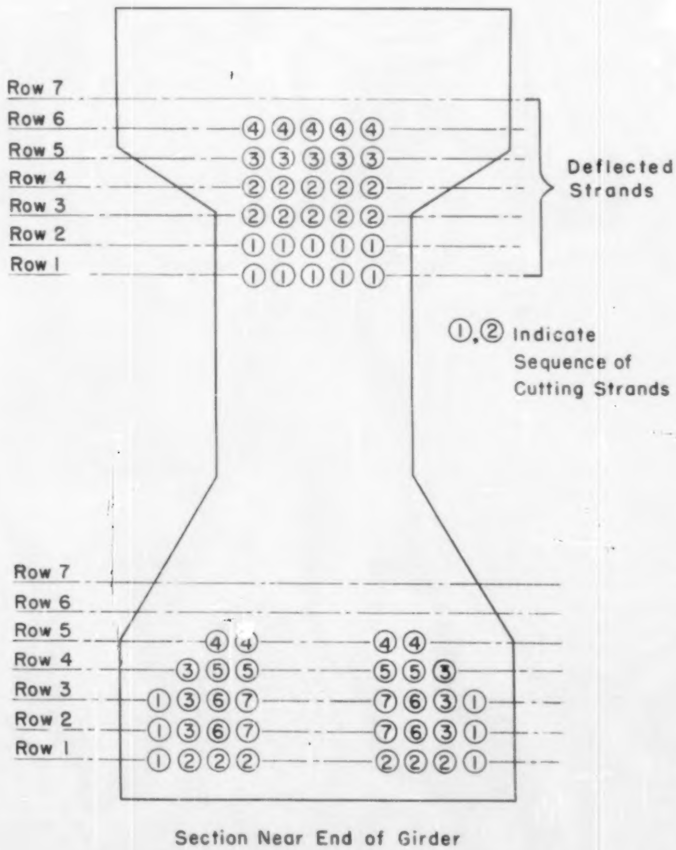


Fig. 2.—Sequence of cutting stressing strands.

48 by 28 in. design, 82 to 64 strands (30 deflected)

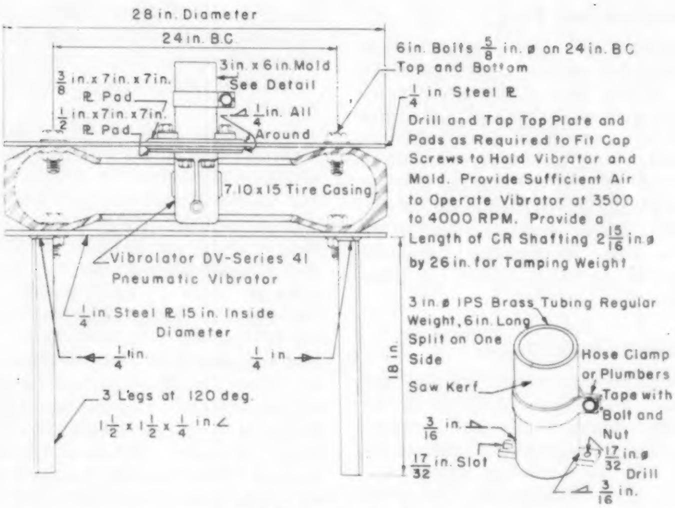


Fig. 3.—Vibrating table.

3 by 6 in. mold detail

steam was shut off, the forms were striped, and cutting of the strands was started immediately. Covers were retained over the girders to prevent too-rapid cooling of the concrete.

Starting at the middle of the bed, the deflected strands were cut with an acetylene torch, using a pattern such that no lateral eccentricity would result. After all the deflected strands had been cut, the hold-down anchors were removed, and finally the bottom straight strands were cut, again following a pattern such that no lateral eccentricity resulted. Figure 2 shows a typical pattern of cutting.

Inspectors were carefully instructed in all phases of the operations, and were provided with the "Inspection Manual" and mimeographed, detailed instructions covering inspection procedures.

Posttensioned Hollow Piles

Concrete components for these piles were cast in 4, 8, and 16-ft lengths in a centrifugal pipe machine and, after a suitable steam curing period, were permitted to cool and then were sprayed with clear membrane curing compound. They were next assembled into piles of the required length, tensioned, and grouted.

Batching of concrete ingredients was done in a semiautomatic plant and mixing was accomplished in a pug mill type mixer. Class R 5000 psi concrete was specified, with 4000 psi to be developed before the stressing force could be applied. Strength of concrete prior to tensioning was determined by means of cylinders field cured with the pile sections. Standard cured specimens were also made. The ordinary 6 by 12-in. compression test cylinder is ill-adapted to the zero slump concrete used in these piles. Following the method developed by the engineer for the Lake Pontchartrain Bridge, which was based on a procedure used in a Western pipe plant, 3 by 6-in. cylinders were made on a vibrating table. This table, shown in Fig. 3, consists of a steel plate fastened to an old tire casing which is supported on legs. A small vibrator is attached to the underside of the plate, and the cylinder mold is attached on top. Concrete is placed in the mold in six lifts, each lift being vibrated for 1 min while a weight of 50 lb is applied to the top. This amount of vibration and pressure is normally sufficient to bring moisture to the surface of the lift, which is roughened before the subsequent layer is placed.

Strength of this concrete, as reflected by 28-day standard cured cylinders,[3] averaged 9160 psi with a high of 13,570. Less than 1 per cent of the specimens broke below 5000 psi. The wide range in strength is due more to the quality of the specimens than to variations in the concrete itself which was batched in a semiautomatic plant, under close inspection. This conclusion rests on the inspector's observation that the air pressure operating the vibrator fluctuated widely and that the small pneumatic vibrator was extremely sensitive to the air pressure, the over-all result being considerable variation in the amount of vibration received by the different specimens.

Stressing of the posttensioned wires was controlled by measurement of the elongation and by jack pressure, with tolerances on the amount of each. In each pile, there were 8 strands of 12 wires each, a total of 96 wires per pile. Tolerances were as follows:

(*a*) Unit tensile stress in wire: 150,000 to 167,000 psi, and

(*b*) Loss of stress in wire after jacking: 10 per cent in any one strand, or 3 per cent for the entire pile.

Under a pressure of 150 psi, a high-early strength cement-water grout was pumped into the ducts containing the wires, and after 24 to 48 hr, depending on the weather, the wires were burned apart at the ring between the piles being stressed and the anchors were removed. Any slippage of wires becomes apparent when the wires are burned off, either at the center ring or at the ends. A fracture under stress, indicated by a cup and cone tensile fracture, reveals a loss of stress. The amount of slippage of the wire in this situation indicates the magnitude of the loss.

Stressing Wire and Strand

Testing of the 0.192-in. wire for posttensioned piles was accomplished by conventional means, using standard grips, and it presented no unusual problems. However, it was felt that there was room for improvement in testing 7-wire strand. Testing consisted of loading the $\frac{7}{16}$-in. diameter strand in tension until failure, and plotting a stress-strain curve for the determination of the 0.2 per cent offset yield point.

The usual method of gripping cable for tension testing is to socket the ends in molten zinc. This has been done previously for prestressing strand with apparently satisfactory results. However, personnel at the local Pittsburgh Testing Laboratory, who were performing tests of the wire and strand, felt that socketing with zinc in the same manner as for other types of cable would lead to possible annealing of the heat-treated strands, thus causing the strand to break in the grips and give erroneous results. Considerable experimental work was therefore undertaken in an attempt to develop a better method. In the procedure finally adopted, the strand end was fluxed in zinc chloride solution after cleaning in gasoline. It was then dipped in pure molten tin at 500 F and held long enough to permit the tin to penetrate the spaces between the wires after which it was withdrawn, cooled and redipped to produce a uniform layer around the strand end in much the same way that wax candles are made. It was found that for $\frac{7}{16}$-in. strand, the tinned end should not exceed $\frac{5}{8}$-in. in diameter for best results.

[3] Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field (C 31 – 57), 1957 Supplement to Book of ASTM Standards, Part 3, p. 295.

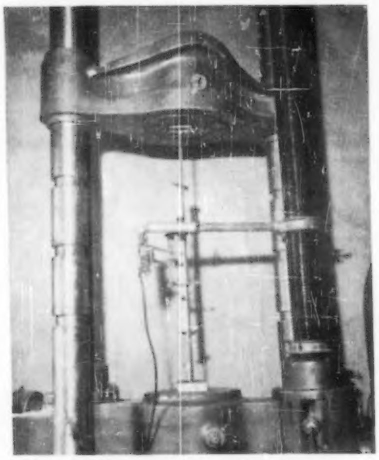


Fig. 4.—Experimental extensometer attached to $\frac{7}{16}$-in. stand.

Measurement of the total elongation in 24 in. was the second problem. While the specifications prescribed that the elongation should be determined as the per cent increase in separation between the jaws of the testing machine, it was felt that a more accurate measurement could be made by use of an extensometer, and a simple experimental extensometer was developed in the laboratory by which measurements to 0.01 in. were possible (Fig. 4). Although rather crudely made, the instrument performed in a very satisfactory manner. Refinements are now being developed, especially in the manner of attaching the extensometer to the strand and in protection of the instrument at the time of fracture of the strand.

The extensometer for producing the stress-strain curve is of standard manufacture, available for any testing machine having a microformer stress-strain recorder. This instrument is, of course, removed after the curve breaks over but before the specimen fractures.

Fabric Bridge Pads

Bearing plates for prestressed concrete girders were required to rest on preformed pads, consisting of multiple layers of cotton duck impregnated and bound with rubber into resilient pads, or on brass wire-inserted asbestos cloth treated with asphaltic base impregnation and compounded with a thermosetting elastomer. A minimum thickness of $\frac{9}{32}$-in. was required. At the time this paper was written, only the cotton duck pads had been used.

Pads were required to pass a permanent set test and a load deformation test. Permanent set was determined by measuring the thickness of a 2 by 2-in. specimen before and after application of the specified compressive load. This test was performed without difficulty. The load deformation test was soon discovered to be extremely sensitive. Load deformations were obtained by measuring the reductions in thickness resulting from compressing 2 by 2-in. specimens perpendicular to the direction of lamination at a rate of 500 lb per min. The "zero" deformation readings were taken at a stress of 5 psi on the specimen, and the maximum load was 2000 psi.

The specifications required that the pad be tested in a machine with platens fixed in a parallel position. To measure deformation of the pad under load, a yoke was attached to the supporting platen, passing up and over the specimen in such a way that a dial gage could be mounted centrally between the yoke and upper platen (Fig. 5). This apparatus, developed by the Robert W. Hunt Co., who performed this portion of the off-site testing, permitted one man to observe and record deformation readings while the specimen was being loaded.

Once the apparatus had been developed, it was found that exact timing of all operations by a stop watch was essential to obtaining reproducible results. It was also found that slight variations in pad thickness, of the magnitude of 0.001 in., caused significant variations in the deformation under a given load.

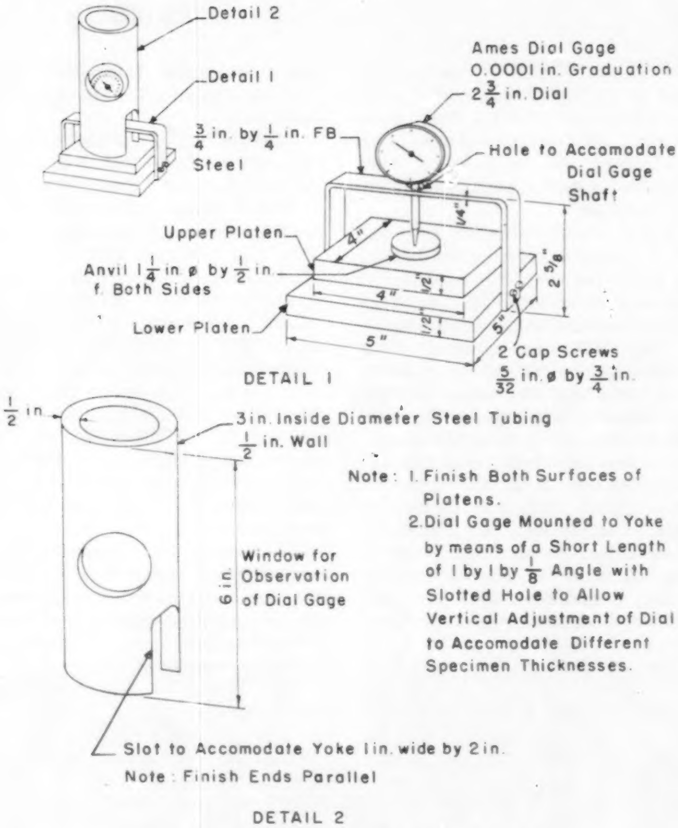


Fig. 5.—Compression device for fabric pads.

Conclusions

As a result of experience to date on this project it may be concluded that the concrete control methods used are workable and effective. Statistical analysis provides a tool that is essential to this control. However, on this or any project, better control will result when a rapid test of concrete quality supplants the 28-day compressive strength test.

Inspection and control methods for prestressed concrete are developing as the industry develops. Satisfactory inspection methods were developed for the stressing arrangements in the plants serving this project.

Testing of such specialized items as fabric pads and stressing strand have required considerable ingenuity in developing techniques that give reproducible results. Further work should be done to standardize these procedures.

DISCUSSION

Mr. H. W. Willis.[1]—I assume the strand is multiple. I would like to know what types of SR-4 strain gages were used; what cement was used; and, if the strand was multiple, on what strand was the gage applied—how many in one location.

Mr. J. J. Waddell (*author*).—I don't know the particular type of SR-4 strain gages used; but they were cemented to the strands in seven or eight locations along one strand at the beginning of each operation. In applying these gages to a strand cable of this type, an error is introduced due to the tendency of the strand to straighten. However, our main objective in using these gages was to determine the relative amounts of strain in the strand—in other words, to determine the distribution throughout the length of the bed. In a 600-bed, there would be as many as 11 or 12 girders. The strand started high at one end; passed down over the hold-downs in one girder; up over the harping frames in between; and so forth. It did this 12 times. There was likely to be a considerable amount of friction developed in between the various hold-downs and frames. Incidentally, on the deflected strands, the stressing load was applied at both ends. We found that on a long bed it was impossible to get a reasonable distribution of stress without applying the stressing load at both ends.

Mr. M. J. Dubinsky.[2]—Mention is made of field-cured test cylinders. In just what manner were they cured?

Mr. Waddell.—The cylinders were cast in steel molds and were cured inside the enclosure with the girders. The enclosure for these girders consisted of one or two layers of canvas or heavy plastic. Placement of the specimens inside the enclosure was critical. In some cases we found that specimens had been set too close to the steam inlets. Strength of such specimens was not representative. It takes a little judgment knowing just where to put them—where the temperature would be representative of the temperature within the enclosure.

Mr. Charles F. Parker.[3]—I would like to ask the author which he thinks is the most positive method—pretensioning or post-tensioning. In Europe I found that there was no pretensioning—it was all post-tensioning.

Mr. Waddell.—I think that the circumstances dictate the method used. On the Northern Illinois Toll Highway we did have some post-tensioned girders. We had one bridge with girders that were 110 ft long, post-tensioned on the site mainly because of the difficulty of hauling them through a rather thickly congested area. I think that economic considerations in each individual case will dictate the type of stressing to be followed. In general, for post-tensioning you do not need the elaborate heavy casting beds that are required for pretensioning. In a pretensioning yard there are loads of a magnitude of 1,000,000 lb that have to be resisted by the deadmen and the beds. In the case of post-tensioning, all of the load is applied to the hardened concrete and is resisted by the member being tensioned. There is no force to be resisted by outside members.

Mr. E. W. Cummings.[4]—You stated that petrographic analysis or examination of some of the gravels proposed for use disclosed the presence of particles which were undesirable but which were not detected by any standard acceptance tests. What were those particles?

Mr. Waddell.—I am not a petrographer or a geologist; but, in general, in that area most of the aggregates are limestone and dolomites. There's quite a lot of chert. Most of these unsound particles were coarse cherts. They are hard; but their specific gravity is low and their absorption is high. Under freezing-and-thawing conditions when they are wet, they will absorb water which will freeze and cause pop-outs and so forth in the concrete.

Mr. Waddell (*authors' closure*).—I wish to thank the discussors for their questions, and also provide some further information. In regard to Mr. Wills' question relative to SR-4 strain gages, I wish to point out that the gage was of a very small and narrow type, and was attached to one wire of the strand with an epoxy resin cement. Sometimes if time was limited, Duco cement was used as it dries faster, but we found that the resin was more waterproof and better for this purpose.

Concerning Mr. Dubinsky's question: Several cylinders were made at a time and placed within the enclosure at a location where the steam would not strike them as it came out of the supply manifold. They were, however, exposed to the steam as it circulated around the prestressed members.

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[1] Research Engineer, Lock Joint Pipe Co., Research and Development Department, Wharton, N. J.

[2] Concrete Testing Unit, Research and Materials Division, Department of Public Works, Commonwealth of Massachusetts, Boston, Mass.

[3] Chief Engineer, W. H. Hinman, Inc., Gorham, Me.

[4] Engineer, Ohio State Highway Testing Laboratory, Department of Highways, Columbus, Ohio.

Fixtures for Testing Pin-End Columns

By A. W. HUBER

A description is given of the design and the performance of column end fixtures with cylindrical bearing surfaces. These fixtures were designed for heavy loads (maximum 2,000,000 lb) and simulate a pin-end condition in one direction and fixed-end condition in the direction at right angles to the first.

The fixtures can be used for axial or eccentric column tests with equal end eccentricities. Adjustments to compensate for uneven bearing and to correct for accidental eccentricity can be made.

IN ORDER to test columns, under known end conditions, special fixtures are required. In general the ideal end conditions assumed in theory must be simulated experimentally.

The experimental part of an investigation carried out at the Fritz Engineering Laboratory, Lehigh University, on "Residual Stress and the Compressive Properties of Steel," called for axial tests of a variety of wide-flange columns (**1**).[1] The column end fixtures described in this report were designed for this purpose.

A knife edge assembly previously had been used at the laboratory for the test of axially loaded columns and of columns under combined thrust and moment (**2**). However, the knife edges did not have sufficient capacity for the heavier sections to be tested in the program. Templin (**3**) presents an interesting design of hydraulically supported end fixtures. These, too, were limited in application to rather low loads. Another design of end fixtures is described by White and Thurlimann (**4**) for the testing of very heavy built-up columns under axial load (capacity of more than 3,000,000 lb). End bearing is provided by approximate line loading through an assembly of plates of subsequently reduced widths. The application of these fixtures is limited to columns that carry high loads, otherwise the accuracy of the test re-

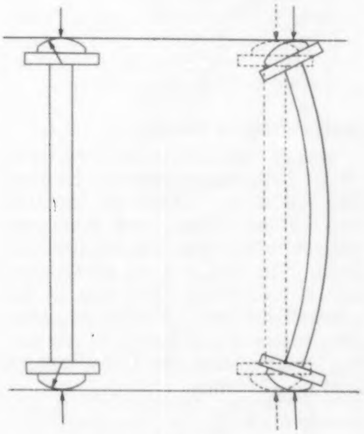

Fig. 1.—End fixture action.

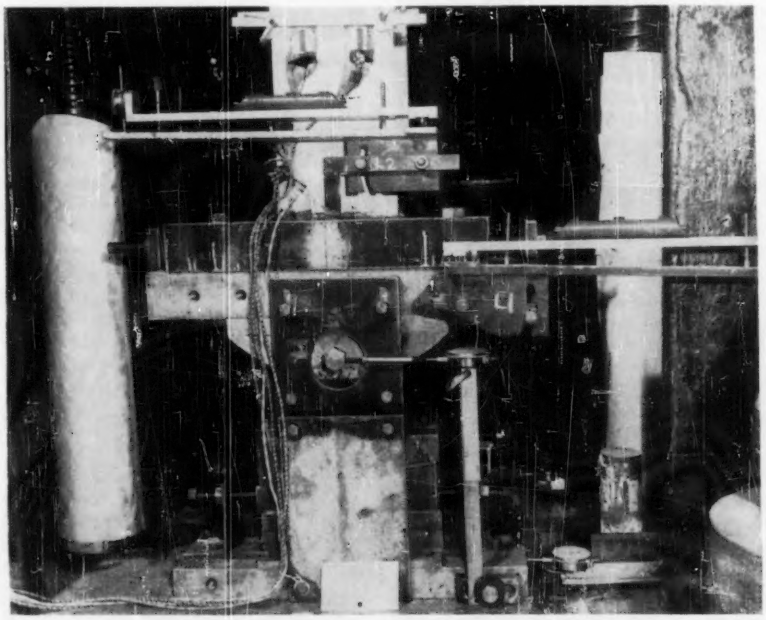

Fig. 2.—Bottom end fixture.

NOTE.—DISCUSSION OF THE PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

ALFONS WILHELM HUBER, a graduate of the Technische Hochschule in Graz, Austria, received his Ph.D. degree at Lehigh University, in 1956. While associated with Lehigh University he played a major part in the development of the project on Influence of Residual Stress on Column Strength and the Mechanical Properties of Rolled Shapes. At present, he is a design engineer for Gruen and Bilfinger in Buenos Aires, Argentina.

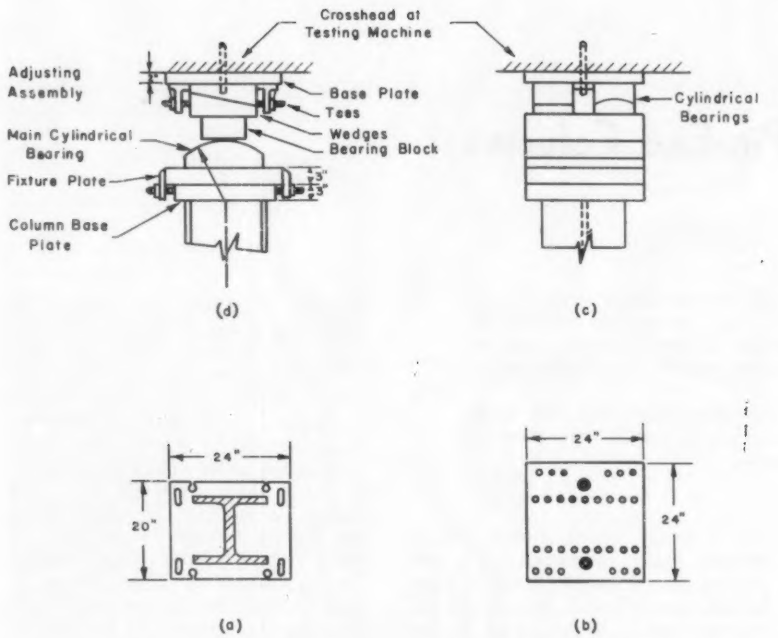

Fig. 3.—Column end fixtures—elements and dimensions.

(*a*) Column base plate.
(*b*) Fixture platen.
(*c*) Assembly side view.
(*d*) Assembly front view.

NOTE: Bottom fixtures are identical with the top fixtures except for the bolt attachment of the base plate.

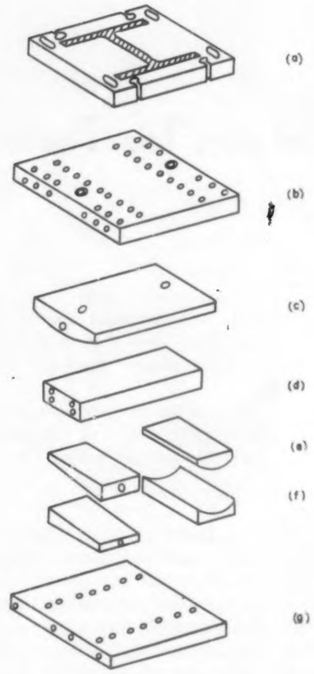

Fig. 4.—Exploded view of bottom end fixtures.

(*a*) Column base plate.
(*b*) Fixture platen.
(*c*) Main cylindrical bearing.
(*d*) Bearing block.
(*e*) Cylindrical bearings.
(*f*) Wedges.
(*g*) Base plate.

sults will be influenced by the end conditions.

The main requirements for the fixtures were a wide load range with a maximum capacity of 2,000,000 lb, low cost, simplicity, the possiblity of adjusting for column imperfections, and finally to simulate pin-ends for the direction of desired buckling of the columns. A solution that satisfies these requirements was obtained by the adoption of a cylindrical bearing surface within an assembly of plates and wedges which could be used for adjustments.

Description of Column End Fixtures

Cylindrical fixtures have been used previously for testing model columns under pin-end condition. Such fixtures simulate a pin-end condition by rolling on the platens as the column bends (Figs. 1 and 8). The cylinder radius is made such that its center is at the end of the column. Thus the line of force will always pass through the same point (Fig. 1).

A close-up of the bottom end fixture is shown in Fig. 2, for an axial column test of a WF section in an 800,000-lb testing machine. Top and bottom fixtures are identical in design. The top fixture is held by screws against the crosshead of the testing machine while the bottom fixture just rests on the testing machine platform. The total weight of both fixtures is 4538 lb. All material used is steel made in accordance with ASTM Specification A7[2] with the exception of the cylindrical surface and the bearing blocks.

The following elements make up the fixture assembly. (They are identified and dimensions are given in Fig. 3. An exploded view is shown in Fig. 4.)

Column Base Plate

The plate (See Fig. 3(*a*)) has slots in the interior for the bolts that fasten it to the fixture platen. At two opposite sides are cutouts that serve as anchorage for four bars which permit a relative movement of the column base plate with respect to the platen (control of eccentricity). The test column is welded to this base plate.

Fixture Platen

This platen (see Fig. 3(*b*)) has a series of drilled and tapped holes for fastening the bolts that hold the column base plate. The cylindrical bearing surface is also attached to it by two screws. At two opposite sides are four small plates which serve as anchorages for the bars that permit relative movement of the column base plate (Fig. 3(*d*)).

Main Cylindrical Bearing

This consists of steel, heat treated to 70-80 Scleroscope surface hardness. The steel is an oil-hardened tool steel with a high carbon and manganese content. The surface is machine finished. The radius of the bearing surface is located at the center of the column base plate. This, then, is also the location of a hypothetical pin, and the actual column length can then be used in calculation.

Bearing Block

This block bears on the cylindrical bearing and serves to distribute the load between the wedges and the small cylindrical bearings. It was also heat-treated to the same hardness as the main cylindrical bearings and is constructed from the same tool steel, as well as having the surface machine finished.

Adjusting Assembly

This assembly consists of wedge blocks, small cylindrical bearings, a base plate, spacers, tees and angles for fixing the location of the various elements.

The adjusting assembly permits the

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[2] Tentative Specification for Structural Steel for Bridges and Buildings (A7-5T), 1958 Book of ASTM Standards, Part 1.

correction of uneven bearing or out-of-squareness of the column for the direction normal to the direction of buckling. This is done by moving the wedges with tie bars that are anchored to stiffened tees; the bearing block thus pivots about the small cylindrical bearing until proper alignment is achieved. The column can be considered fully fixed for this direction. This end condition is desirable because no lateral bracing will then be required for a majority of column sections for a buckling test about the strong axis.

The fixture assembly is held together by side plates (Fig. 2). The lower side plate in Fig. 2 holds the adjusting assembly together. The upper side plate in Fig. 2 is necessary for the column setup. The upper screws in the slotted holes are removed during the test and the cylindrical bearing can roll on the bearing block. A stud in the center of a circular cutout on the upper side plate limits the total movement of the cylindrical bearing. This prevents the column from tipping over when the load is accidentally released.

Column End Fixture Design

The fixtures were designed for a maximum load of 2,000,000 lb. The main cylindrical bearing and the bearing block in contact with it were constructed from special tool steel heat-treated to 70-80 Scleroscope surface hardness in order to sustain high bearing stresses elastically. All other parts were made of untreated steel, ASTM Specification A 7.

The bearing stresses along the area of contact of the cylindrical and horizontal surface were calculated by the equations of Hertz (**6**). (Both contacting surfaces are assumed to have equal modulus of elasticity, E, and Poisson's ratio equal to 0.3.)

$$\sigma_{max} = 0.591 \sqrt{\frac{pE}{2r}} = 209{,}000 \text{ psi}$$

where:

p is the pressure per linear inch $\frac{(2{,}000{,}000)}{24}$,

r, the radius of the cylindrical surface ($r = 10$ in.), and

E, the modulus of elasticity (assumed as 30,000,000 psi).

The width of the bearing area is given by

$$b = 2.15 \sqrt{\frac{2pr}{E}} = 0.506 \text{ in.}$$

Test Setup and Alignment

The setup and alignment of the fixtures and test specimens is as follows: First, the upper fixture is placed in position on the testing machine platform, after which the movable crosshead of the testing machine is lowered, the fixture is attached to it, and the head is taken to the desired position. Next, the column test specimen with base plates welded in position is brought in vertically, is rolled under the upper fixture, and by means of the upper base plate is attached to this fixture with bolts. Finally, the bottom fixture is rolled underneath and is set on the testing machine table and the column is lowered and bolted at the bottom (Fig. 5).

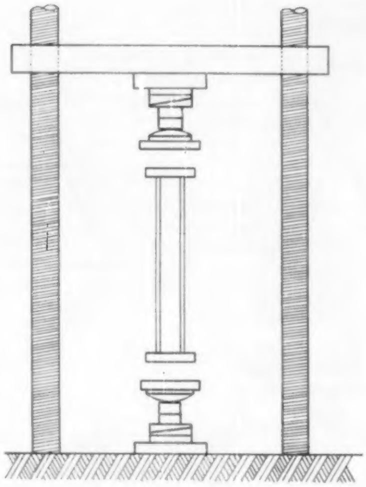

Fig. 5.—Column test setup (schematic).

The alignment is first done geometrically and then checked by loading within the elastic limit of the material. This check is made by strain readings, deflection and rotation measurements and plumb bob or by transit. The following adjustments can then be made on the top and bottom fixtures:

Plumbness

In the direction of buckling.—The crosshead is raised with the test specimen and the line of contact is relocated between the cylindrical surface and the bearing block on the lower fixture.

In the normal direction.—The wedges are either raised or lowered as required.

Eccentricity

The column base plates are moved in relation to the fixture platens. (This can be done under a low load of a few thousand pounds.)

Uneven Bearing

This can be corrected by the adjustments listed under "plumbness." (Here also, it is not necessary to remove the load completely on the specimen.)

A typical column test setup is shown in Fig. 6, a test of a 30-ft column (14 WF111) in the 5,000,000-lb testing machine at Fritz Laboratory, in Bethlehem, Pa.

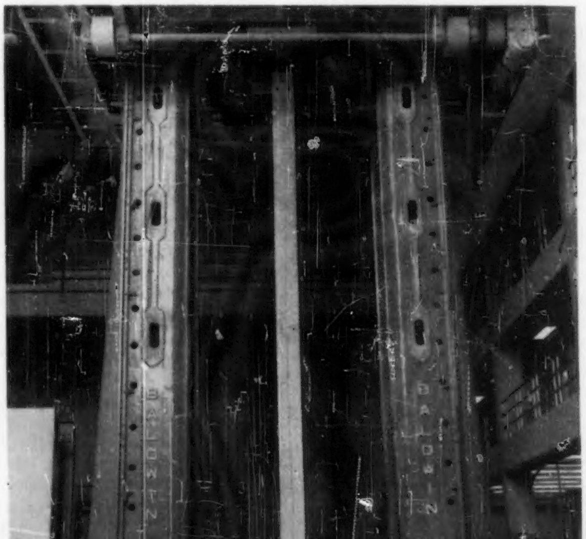

Fig. 6.—Axial load test of 14 WF111 column.

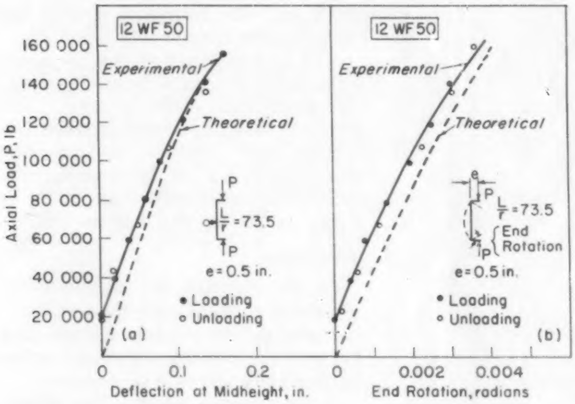

Fig. 7.—Results of eccentric load test of 12 WF 50 column.

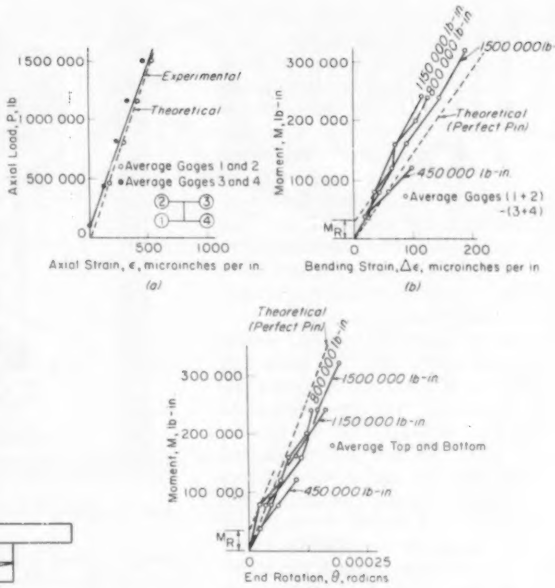

Fig. 9.—Results of end fixture tests.

Tests of the Column End Fixtures

The object of these preliminary tests was to find out if any appreciable end restraint is provided by the fixtures as they roll on the platens during column deflection since this restraint should be so small that it can be safely neglected. Two different tests were made to check the performance of the fixtures.

1. For a check of the lower range of loading, a test on an eccentrically loaded column was performed in the elastic range. The test results are compared with theoretical predictions in Fig. 7. The load-deflection relation at midheight is shown in Fig. 7(*a*). The rotations of the lower column base plate is shown as a function of the load in Fig. 7(*b*). (Due to elastic deformations of the base plate it is necessary to retighten the screws holding the base plate to the platen. If this is done at 100,000 lb load intervals the relative rotation is negligible between the column base plates and the fixtures platens.)

The results of this test indicated that no appreciable restraint is provided by the fixtures. A restraint would have reduced the magnitude of the deflections and end rotations.

2. To test the fixtures to 75 per cent of their theoretical design capacity a second test was performed. The setup is shown schematically in Fig. 8. A short specimen was centered between the fixtures. A jack connected to a dynamometer for measuring the force was fixed eccentrically between the fixtures. Thereby an additional axial force and a moment could be applied and the deformations—end rotations and bending strains—determined. Measurements were made by level bars attached to the fixtures and dial gages between base plates. The test results are shown in Fig. 9. The axial load is plotted *versus* the axial strain (calculated from the dial gages) in

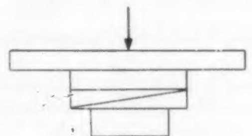

Fig. 8.—Test of end fixtures (schematic).

Fig. 9(*a*). The moment (calculated from the jack load) is shown as a function of bending strain, $\Delta\epsilon$, and end rotation for various values of axial load (450,000, 800,000, 1,150,000 and 1,500,000 lb) on Figs. 9(*b*) and 9(*c*). The theoretical curves (under the assumption of a perfect pin) are also shown.

While the experimental results show some scatter, there is little difference between the curves for the different axial loads and the theoretical curves for small deformations. Deformations were observed immediately upon application of moment. In order to obtain a numerical estimate of the resisting moment a line parallel to the theoretical curve is drawn in Figs. 9(*b*) amd (*c*). For the maximum test load of 1,500,000 lb this resisting moment was about 25,000 lb-in. If this result is interpreted in terms of axial and bending strain of a 10 by 10 in. section, the bending strain amounts to 1 per cent of the axial strain. The actual resistance was less for all loads and small deformations. In addition, the test condition was more severe because of the shortness of the specimen. A slender column is expected to exhibit even less resistance to rotations of the ends.

An inspection of the bearing blocks after the test did not indicate any permanent set.

Finally, it is concluded that the fixtures have negligible end restraint for all practical purposes.

Acknowledgments:

This report presents a part of the studies made during the course of a 3-yr research program on the influence of residual stress on column strength. These studies are sponsored jointly by the Column Research Council, the Pennsylvania Department of Highways and the Bureau of Public Roads and by the National Science Foundation. The work was carried out at the Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa., under the direction of Lynn S. Beedle. William J. Eney is director of the labora-

tory. The funds for the purchase of the end fixtures were provided by Lehihh University. The fixtures were manufactured by the Bethlehem Steel Corp.

The suggestions of Karl de Vries of the Bethlehem Steel Co., Samuel Errera, engineer of tests, and of Kenneth Harpel, foreman, of Fritz Engineering Laboratory, are much appreciated. In the preparation of the report Marie Kenney also assisted. Her cooperation is gratefully appreciated.

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Oxidation of Gear Lubricants—Laboratory and Field*

By M. J. POHORILLA and W. HART

The problems associated with adequate evaluation of the performance of gear lubricants have become more complex in recent years. Today the average vehicle delivers more horsepower and operates at sustained higher speeds than did its counterpart of a few years ago. Design changes have been made which apply greater stresses to the oil than had been encountered previously. A demand for greater load-carrying capacity has resulted from these trends. The same factors have brought about an increase in transmission and differential temperatures so that present-day gear lubricants are required to have a high degree of resistance to oxidation. The purpose of this paper is to describe work done on the oxidation stability of these materials—an area which has not received the same degree of emphasis as that placed upon wear and load-carrying capacity. Straight mineral oil gear lubricants inhibited against oxidation were used in the majority of the experiments. A laboratory oxidation test which has shown correlation with limited field test work will be described. Both laboratory and field test results are presented to demonstrate the correlation. Some coverage will also be devoted to the stability of lubricants meeting the proposed API Service GL-4 classification as measured by the laboratory test.

Classical Oxidation Test Methods

Petroleum technologists have long been faced with the problem of employing laboratory procedures which satisfactorily predict lubricant behavior in service. The large number of laboratory oxidation tests in use indicates that no one test has received universal acceptance. This is not surprising since oxidation of lubricants is dependent upon many external factors which are difficult to duplicate precisely in one single test. Those tests which have been widely used include the Sligh oxidation test,[1] Indiana oxidation test,[2] and the procedure of Dornte[3] as modified by Fenske[4] and others.

Most laboratory-bench oxidation tests consist simply of heated glass tubes or cylinders containing a given volume of lubricant where air or oxygen is bubbled through the liquid at a prescribed rate. Catalyst in the form of oil-soluble metal salts, metal coils, or pieces of metal are generally present. The particular test conditions utilized are generally for the purpose of accelerating hydrocarbon degradation rather than simulating the particular environment in which the lubricant must function. The accelerated rates of oxidation very often make it difficult to evaluate differences between gear lubricants, particularly those which contain additives.

In Fig. 1 Indiana oxidation test data

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[1] T. S. Sligh, "An Oxidation Method for Measuring The Stability of Mineral Oils," *Proceedings*, Am. Soc. Testing Mats., Vol. 24, Part II, p. 964 (1924).

[2] D. P. Barnard, E. R. Barnard, T. H. Rogers, B. H. Shoemaker, and R. W. Wilkin, "Causes and Effect of Sludge Formation in Motor Oils," *SAE Journal*, Soc. Automotive Engrs., Vol. 34, May, 1934, pp. 167–181.

[3] R. W. Dornte, "Oxidation of White Oils," *Industrial Engineering Chemistry*, Vol. 28, pp. 26–30 (1936).

[4] M. R. Fenske, C. E. Stevenson, N. D. Lawson, G. Herbolsheimer, and E. F. Koch, "Oxidation of Lubricating Oils—Factors Controlling Oxidation Stability," *Industrial Engineering Chemistry*, Vol. 33, pp. 516–524 (1941).

at 340 F are plotted for a straight mineral oil SAE 90-140 gear lubricant and the same product compounded with two different inhibitor systems. Under these conditions it is not possible to differentiate between the oxidation stability of these gear lubricants. Lowering the test temperature to 300 F, which more closely approaches the most severe field operation conditions, still does not distinguish the stability of one product from another. Field test and other laboratory data to be reported later in this discussion indicate that significant differences actually do exist between these gear lubricants.

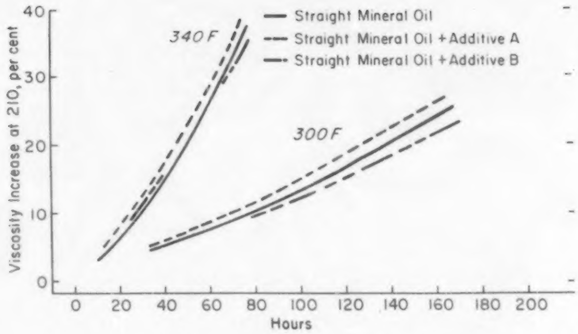

Fig. 1.—Indiana oxidation test.

Cycling Oxidation Test

Because of the failure of the classical type of oxidation test to separate differences between gear lubricants, a new procedure was developed. This test was based upon simulating the oxidative conditions and environment experienced by a gear lubricant in the field. The very simple apparatus for this test is shown in Fig. 2. It consists of a 1000-ml three-necked flask fitted with a thermometer, stirrer, and a capillary vent tube of approximately 1.0-mm bore. Heat is supplied by a conventional electric mantle. The stirrer is positioned near the liquid surface to provide maximum splashing and aeration such as would be provided by running gears. Approximately 600 ml of gear oil is charged to the flask for each test.

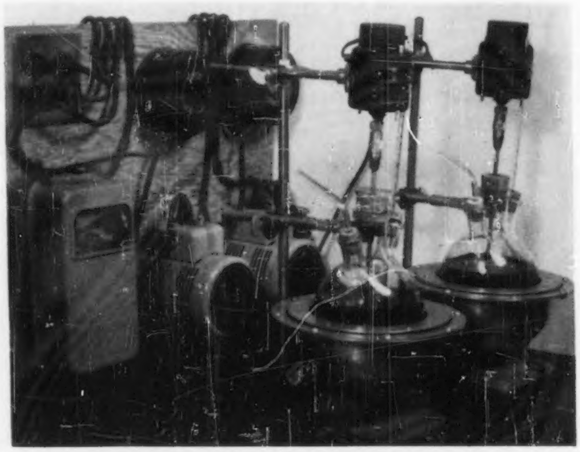

Fig. 2.—Cycling oxidation test apparatus.

The test is operated under cyclic temperature conditions where the gear lubricant is maintained at 300 F for 4 hr followed by a 2-hr shutdown period. Heat and stirring are discontinued during the shutdown cycle and the gear lubricant permitted to cool to equilibrium temperature. No air or oxygen is introduced into the liquid other than that which breathes into the flask *via* the vent tube during the cooling cycle. This alternating cycle is easily maintained by an automatic program control to permit continuous operation.

A catalyst in the form of an oil-soluble iron salt was employed. However, metallic catalysts such as coils, filings, and machined portions of transmission parts have been employed with success in other investigations.

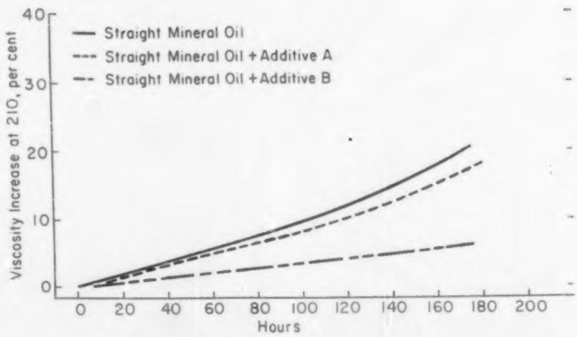

Fig. 3.—Cycling oxidation test.

Data from the cycling oxidation test procedure for the three gear lubricants that were evaluated in the Indiana test are given in Fig. 3. The gear lubricant containing additive A is slightly more stable and the gear lubricant containing additive B is considerably more stable than the straight mineral oil. Oxidation was conducted for a total of about 168 hr, which is the same length of time employed in the Indiana test at 300 F where no advantages could be determined with the use of either additive.

Field Test Data

Two field tests evaluating the oxidation stability of gear lubricants have been conducted which yielded data pertinent to this discussion. In the first, the spiral-bevel differentials of a fleet of semitrailers used in gasoline bulk haul operations were used. A comparison was made of the oxidation stability of the straight mineral oil and the straight mineral oil inhibited with additive A for which laboratory test data have been presented. In Fig. 4 are shown the average viscosity increases at 210 F with test miles for these lubricants. The straight mineral oil showed a substantial increase in viscosity as early as 20,000 miles. The inhibited oil ran for 100,000 miles with only a minor increase in the viscosity.

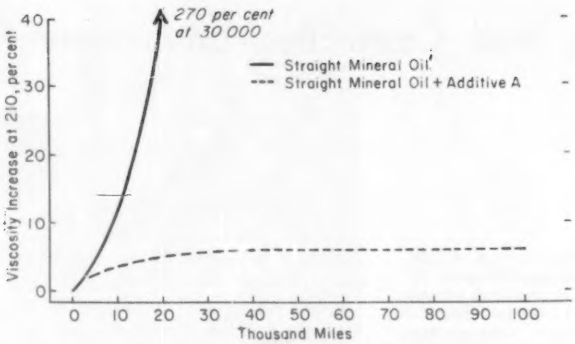

Fig. 4.—Differential field test.

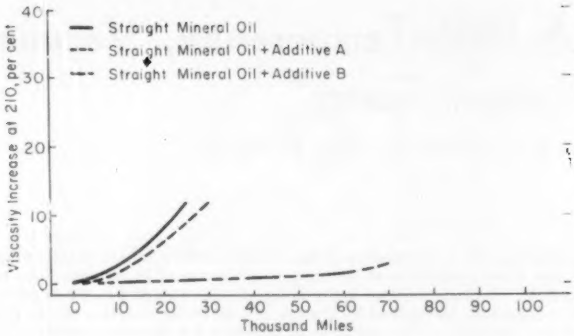

Fig. 5.—Transmission field test.

In the period following this work it was found that more severe conditions were being developed in the gear cases of later model vehicles and that more adequate inhibition of the lubricant was desirable. The cycling laboratory test which has been described was developed using the results of the differential field test to aid in setting up a correlation. Further work produced an inhibitor system which markedly extended the laboratory test life of the gear lubricant. As a result of this, a field test in the transmissions of a fleet of semitrailers used in a long distance motor freight operation was conducted. In Fig. 5 are shown the average viscosity increases at 210 F with test miles for the three lubricants for which cycling oxidation test data have been presented (Fig. 3). Again the straight mineral oil showed a rapid increase in viscosity within 20,000 test miles. The oil inhibited with additive A showed some improvement but still exhibited an undesirable degree of thickening at 30,000 miles. The oil inhibited with additive B accumulated 70,000 miles with practically no increase in viscosity. These data substantiate the prediction of the laboratory oxidation test with regard to the relative stability of these three gear lubricants.

Laboratory Test Data for API Service GL-4 Gear Lubricants

The oxidation stability of multipurpose type gear lubricants has also been studied in the cycling oxidation test at 300 F. A base oil in the SAE 90 range was compounded with additive C to meet the requirements of the MIL-L-2105 specifications.[5] A second gear lubricant formulated from the base oil contained additive D in an amount requisite for the proposed Multipurpose-Type Gear Lubricants (API Service GL-4). The viscosity increase exhibited by the MIL-L-2105 type gear lubricant was only slightly greater than the original base oil, as shown in Fig. 6. However, the lubricant containing additive D was appreciably less stable. This greater susceptibility toward oxidation is also apparent from the amount of sludge produced during these tests as depicted in Fig. 7.

In developing new additives such as additive D, the major emphasis has been placed upon greater chemical activity so as to enhance their load-carrying capacity. It may be this very activity which contributes toward their greater ease of oxidation. Experiments have demonstrated that these additives will decompose thermally at approximately 300 to 325 F. Although it may be legitimately argued that actual service conditions do not generally approach 300 F, nevertheless these test data point up the need for careful field study to determine whether the advantages of these additives in reducing wear may not be minimized by poorer oxidation stability.

Summary

The procedure and equipment for a simple laboratory test for the evaluation of the oxidation stability of gear lubricants is designed to simulate the environment to which the lubricant is exposed in a gear case. This test has been shown to correlate with field experience with inhibited straight mineral oil systems. It also indicates that the proposed Multipurpose-Type Gear Lubricants (API Service GL-4) may be less stable to oxidation than the current products. In a period of increasing temperatures in transmissions and differentials, this is a factor which should receive further attention.

Acknowledgment:

The authors would like to take this opportunity to express their appreciation to the Kendall Refining Co. for permission to present this paper and to F. I. L. Lawrence, C. E. Hulme, J. P. McKittrick, and J. Brenneman for their cooperation and assistance in obtaining the subject material.

[5] MIL-L-2105, Military Specification, Lubricant, Gear, Universal (April 7, 1950).

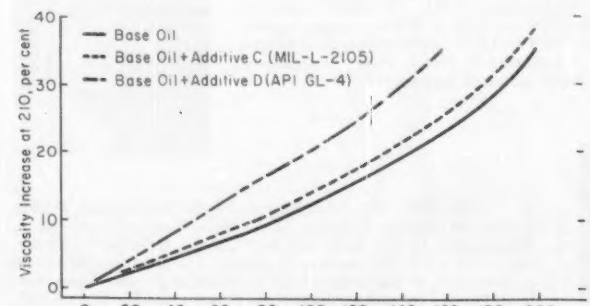

Fig. 6.—Cycling oxidation test.

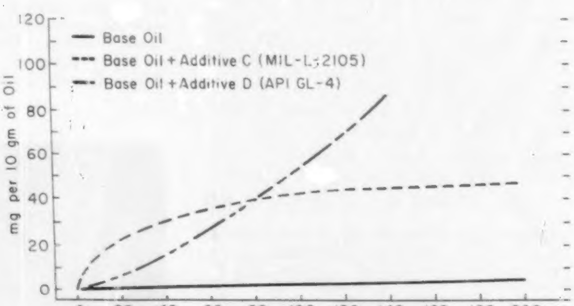

Fig. 7.—Cycling oxidation test. Sludge formation.

A High-Temperature, Vacuum, and Controlled-Environment Fatigue Tester*

By G. J. DANEK, JR., and M. R. ACHTER

Equipment has been developed for reverse bending fatigue at elevated temperature in vacuum. Large strain amplitudes at low frequencies are used to produce failures in approximately 10^5 cycles. A major problem in the design of such equipment, the transmission of motion through a vacuum seal, was solved by the use of a magnetic coupling driven at the resonant frequency of the specimen. Two methods of vibrating the specimen were developed. One arrangement uses two oscillating permanent magnets outside the vacuum chamber while the other employs two electromagnets excited alternately. Provision has been made for automatically stopping the test when a crack has developed through the use of a thyratron circuit. Fatigue data are presented for type 316 stainless steel in a vacuum of 3×10^{-5} mm of mercury through a range of stresses at 1500 F.

PROBLEMS involving thermal fatigue of lightweight, high-temperature nuclear power reactors and operation of aircraft structures at high aerodynamic heating temperatures has stimulated interest in studies of cyclic, high-strain amplitude loading at elevated temperatures which result in fatigue lives of less than 10^5 cycles. Since materials in such uses must serve in environments, both liquid and gaseous, for which there is no background of experience, a program has been started to study the effect of environment on high-temperature fatigue at high-strain amplitudes and the mechanism by which these effects are produced. There are no commercial fatigue machines designed or readily adaptable for such testing. Welch and Wilson **(1)**[1] have described a high temperature fatigue machine for testing vibrating reed type specimens employing a magnetic coupling. Equipment has been developed adapting this principle to fatigue at 1500 F in vacuum which is to serve as the reference for comparison with other environments.

Description of Apparatus

The specimen is gripped in an upright position inside a cylindrical vacuum chamber which is enclosed in a split type resistance furnace, Fig. 1. In the design of equipment for testing in controlled environments, the transmission of motion through a vacuum-tight seal is a major problem which was solved by the use of a magnetic coupling. Two methods of vibrating the specimen at its resonant frequency were developed; one of them uses two oscillating permanent magnets on the outside of the vacuum chamber while the other employs two electromagnets excited alternately. Each scheme was found suitable for the purpose and each had certain advantages and disadvantages.

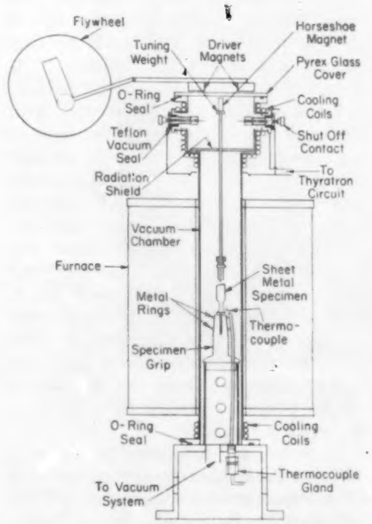

Fig. 1.—Schematic diagram of fatigue tester illustrating mechanical drive.

Mechanical Oscillation

The mechanical system, shown in Fig. 1, consists of a horseshoe permanent magnet, fixed to the end of the specimen assembly, which is excited by two oscillating permanent magnets exterior to the vacuum chamber and driven by an eccentric. Tuning of the driver to the resonant frequency of the specimen is accomplished by means of a variable speed torque converter. The amplitude of vibration is set by adjustment of the eccentricity of the flywheel.

An inherent control problem in this type of mechanism is drift of the center of vibration. By orienting the magnets so that the interior one is repelled by the other two, drift is minimized since the specimen seeks a position of equilibrium between the driver magnets. The center of vibration is set at the start of the test by slight adjustments of the exterior magnets.

This mechanical system is simple and easy to construct but has the disadvantage that it must be stopped for adjustment of the amplitude and center of vibration.

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Sixty-first Annual Meeting of the Society, June 22-27, 1958.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

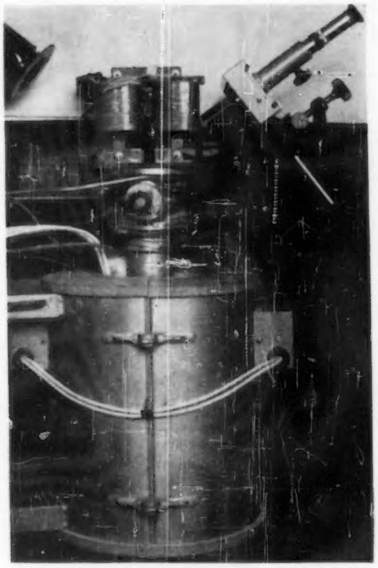

Fig. 2.—Fatigue tester illustrating electromagnet drive.

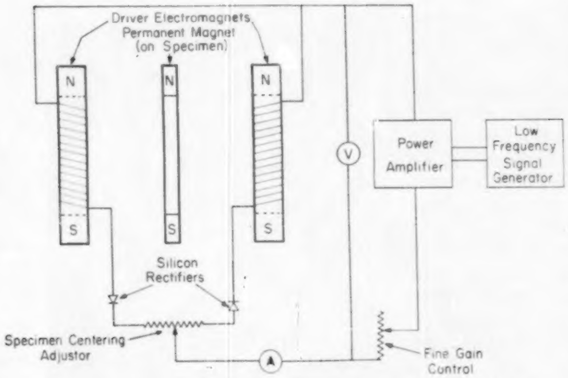

Fig. 3.—Schematic wiring diagram for electromagnet drive.

Fig. 4.—Specimen and grip assembly.

Electromagnet Drive

The position of the magnets for the electromagnet drive is shown in Fig. 2. As in the mechanical system, the vibration is stabilized by orienting the specimen magnet so that it is repelled by the other two.

A schematic wiring diagram is shown in Fig. 3. The a-c signal from a variable frequency generator is amplified and passed through oppositely oriented silicon rectifiers causing the electromagnets to operate 180 deg out of phase. Adjustments of amplitude are made at the start of the test by means of the fine gain control; adjustments of the center of vibration are made by the specimen-centering control which changes the relative strengths of the two electromagnets.

For optimum stability it was found that the distance between poles of the permanent magnet should be about the same as that of the electromagnets. The usable flux output of the electromagnets is limited by the strength of the specimen magnet. If the electromagnets are much stronger than the permanent magnet, attraction instead of repulsion will result and the specimen will drift to one side of the center of vibration. It is also necessary to match the strengths and sizes of interior and exterior magnets on the mechanical drive system.

Using the 30-g permanent magnet shown in Fig. 4, an amplifier output of 15 w is needed for the largest amplitude tests while 0.6 w is sufficient for the smallest amplitude used.

The amplifier is a direct current, transformerless electron tube circuit which has a flat output down to 1 cps but cannot be used at lower frequencies, while the mechanical drive may be used at any frequency from 0 to 7 cps. However, the electromagnet drive has the advantage of being suitable for high-frequency work if certain control systems are added, as explained later.

Details of Construction

Details of construction are shown in Figs. 1, 2, and 4. The furnace is of the split type and can be swung away to permit rapid cooling of the apparatus. Inconel is used for the vacuum chamber and grip assembly. Although an inverted position would help to stabilize the center of vibration, the specimen is gripped in the upright position as shown in Fig. 4 in anticipation of the use of liquid environments in the future. The grip assembly, also designed for use in liquids, employs Inconel rings forced down over a split cone to provide secure clamping which can easily be disassembled by removal of the rings.

The thermocouple bead is wired to the specimen just below the minimum section. It has been determined that this position does not affect the resonant frequency of vibration or the location of the crack. Details of specimen geometry are shown in Fig. 5. Nominal dimensions are 0.187 in. across the reduced section width, *b*, and 0.050 in. in thickness, *d*. The specimen assembly, shown in Figs. 1 and 4, consists of an S-816 coupling and rod to which the magnet is attached. The entire assembly is $12\frac{1}{4}$ in. long from the reduced section to the top of the magnet.

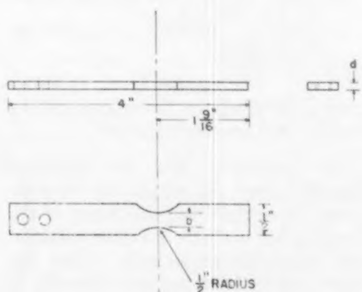

Fig. 5.—Sheet metal fatigue specimen.

Automatic Shut-Off

A device, similar to the thyratron circuit mentioned by Welch and Wilson **(1)**, has been developed to terminate the test automatically. Once every cycle the specimen extension rod strikes each contact, Fig. 1, completing the circuit. As a crack is formed, the natural frequency of the specimen falls, and since it is no longer in resonance with the driver, the amplitude is reduced to the point where contact is no longer made and the thyratron circuit interrupts the power to the equipment. As there is a tendency for the center of vibration to drift when a crack starts to form, two contacts are required to prevent the possibility of premature termination of the test. These contacts are made of 5-mil diameter piano wire which, it has been determined, do not affect the amplitude or frequency of vibration.

Experimental Procedure

Operation of Apparatus

All tests were run at the resonant frequency of the specimens, which varied from 264 to 298 cpm. As shown in Fig. 6, the resonant frequency of vibration is decreased as the amplitude is increased. In order to test all specimens at approximately the same frequency, it becomes necessary to select a heavier tuning weight for smaller amplitudes of vibration. In this series of preliminary tests, extreme care was not exercised to achieve the same frequency for each specimen.

After the system is pumped down by a conventional mechanical and diffusion pump combination to 3×10^{-5} mm of mercury, the furnace is brought to test temperature and the pressure again is allowed to reach 3×10^{-5} before the test is begun. It has been found that operation at this pressure results in bright specimens of type 316 stainless steel at 1500 F. While readings are being taken by means of the telescope shown in Fig. 2, the amplitude is increased and the driving mechanism is tuned to resonance, which is considered the point of maximum amplitude as the frequency is varied. A stroboscope is used to measure the frequency of vibration. Figure 7 shows the variation of amplitude that results as the oscillator frequency is changed to find the point of resonance. In accord with theory (2), the increased damping at larger amplitudes results in flatter curves and a shift of the resonance point to lower frequencies.

When the desired amplitude of vibration is reached, the automatic shut-off is turned on by advancing each contact 0.025 in. beyond the point where it first touches the vibrating specimen. Then adjustments are made to position the center of vibration.

Stability of Amplitude

Stability of vibration amplitudes was found to be better when operating at higher stresses, as can be understood by reference to Fig. 7. On the right-hand side of these curves, the driver frequency is greater than that of the resonant frequency of the specimen, and as the fatigue damage accumulates, the amplitude decreases at the rate indicated by this side of the curve. Therefore, at high stresses where the resonance curve is flat, the amplitude remains constant within 1 per cent for most of the test until a crack is initiated, at which time there is a sharp decrease in amplitude. However, at low amplitudes, due to the sharper resonance peak, the amplitude decreases steadily and results in early termination of the test before a visible crack is formed. For this reason, in the present investigation, tests were limited to relatively high amplitudes where there is a greater constancy of stress. If it should be desired to use this equipment for low-stress, high-frequency work, it would be necessary either to retune the driver periodically or develop a feedback system that would automatically keep it in resonance. As an alternative, a servo mechanism such as described by Welch and Wilson could be used to hold amplitude constant.

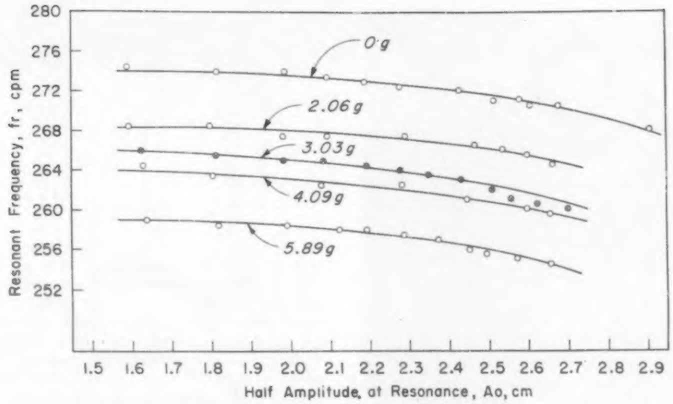

Fig. 6.—Resonant frequency *versus* half amplitude at resonance for five tuning weights.

Stress Calculations

Epremian and Mehl (3) have described a method of calculating the stress in a vibrating reed, which applied to the present case leads to the following equation:

$$S = \frac{\omega^2}{Z}\left[(MAl)_m + (MAl)_t + (MAl)_e\right] \quad (1)$$

where:

S = stress, psi,
M_m = mass of magnet, lb per in. per sec^2,
M_t = mass of tuning weight, lb per in. per sec^2,
M_e = effective mass of specimen and rod,
A = amplitude of vibration, in.,
l = distance of mass from reduced section, in.,
ω = frequency of vibration in radians per sec, and,
Z = section modulus at reduced section, in.^{3}

NOTE: The subscripts m, t, and e refer respectively, to the magnet, tuning weight, and specimen and rod.

All quantities may be measured directly except M_e which may be computed by determining the shape of the bending curve of the vibrating specimen and integrating numerically. Since the shape cannot be determined directly, it was calculated by means of the Stodola construction as explained by Welch and Wilson (1), a method involving a series of successive approximations requiring tedious numerical operations and graphical integrations.

A considerably shorter procedure, suitable for the conditions of the present investigation, was developed using the curves in Fig. 6. If it is assumed that at a given amplitude of vibration the stress is independent of frequency, Eq 1 may be written twice, the stresses set equal to each other, and, in principle, M_e may be computed directly. Since this would involve the use of small differences of large numbers, resulting in large errors, the method of successive trials was used instead. The stress at a given amplitude of vibration is computed at five frequencies for each trial value of M_e, using the values for tuning weight read from the five curves of Fig. 6. That trial value of M_e which yields a group of five stresses whose values are the most nearly identical is taken as the correct one. As an example, the

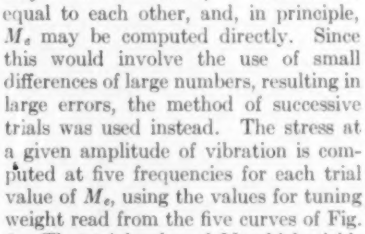

Fig. 7.—Half amplitude *versus* frequency at three-power levels.

Stodola construction gives a value of M_e of 6.12×10^{-5} lb per in. per sec^2 for an amplitude of 2.02 cm and zero tuning weight, while the method outlined above leads to 6.0×10^{-5} at 1.85 and 2.65 cm amplitude. Since in the present case the specimen assembly and rod contribute only 25 per cent of the total stress, this difference in M_e would result in an error in stress of 0.5 per cent. An additional advantage of this method is that it is not necessary to know the elastic moduli at elevated temperature or the temperature gradient along the specimen assembly and rod, data which would be necessary for the Stodola method. However, in both these methods, M_e must be determined for each temperature and material employed. Therefore, the trial value method requires that calibration curves such as shown in Fig. 6 must be repeated for each M_e determination.

Errors in Stress Calculation

Considering the terms in Eq 1, an estimate of the maximum error can be made. The amplitude of vibration is read to 0.001 cm and is reproducible to 0.005 cm, which can contribute an error of approximately 0.2 per cent. Using the stroboscope, frequency is read to $\frac{1}{2}$ cpm, is accurate to 0.3 per cent and accounts for a possible error of 0.6 per cent in the stress. Length and mass errors are negligible except for the effective mass of the specimen assembly which, as discussed previously could contribute an error of 0.5 per cent. These sources of uncertainty combine to result in a maximum error of 1.3 per cent in calculated stress.

Results and Discussion

The data presented in Fig. 8, which summarizes the operating experience at 1500 F for both the mechanical and electromagnet drive, indicate no more scatter than is generally experienced in fatigue testing. Since fatigue studies at relatively low temperatures show a large effect of environment **(4,5,6,7)** it is expected that the present sensitivity is sufficient to permit evaluation of atmosphere effects on a fine scale.

Even though two different driving mechanisms are used, the resulting data are comparable and indicate no great difference in deformation characteristics. However, since it was found that the vibration could be controlled more accurately and conveniently by means of the electromagnets, and as a servo mechanism can be added readily to electronic equipment, it is considered that the electromagnet drive is better suited for life tests.

In vacuum fatigue, no appreciable oxidation takes place; therefore, in addition to environment studies, this equipment may be used for metallographic investigations of fatigue damage and crack initiation and growth at elevated temperatures. Figure 9, which shows a typical crack in a failed specimen, points out the type of study that may be made of surface rumpling, probably substructure formation, which precedes cracking.

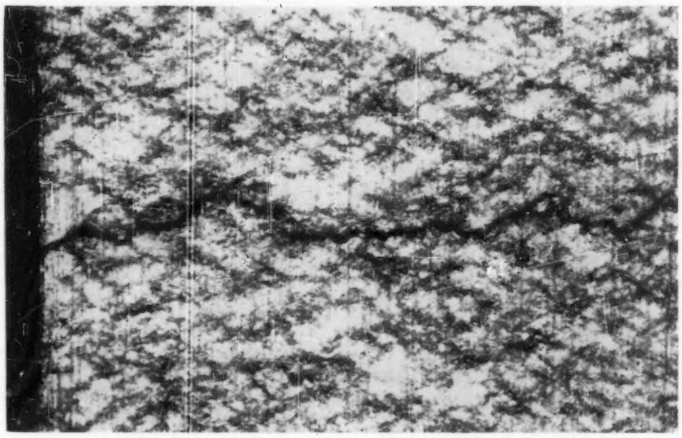

Fig. 9.—Crack in failed stainless steel No. 316.
39,400 cycles at 39.4×10^3 psi. ($\times 100$)

Acknowledgment:

A. C. Yingling and S. J. McKaye aided in the design and construction of the equipment, and C. D. Carpenter designed the automatic shut-off. This program was supported by Bureau of Aeronautics, Code NP.

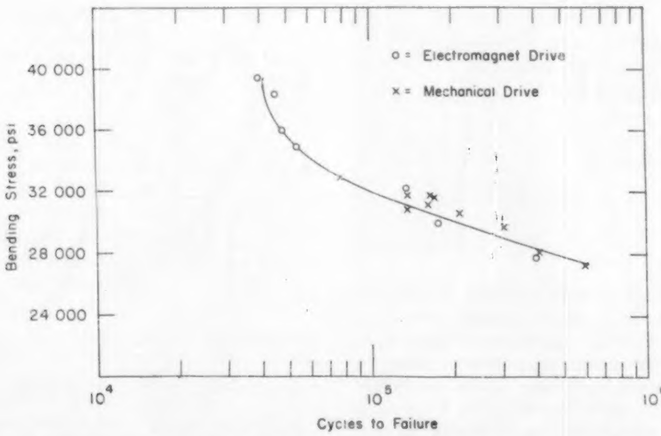

Fig. 8.—Stress *versus* cycles to failure for stainless steel No. 316 at 1500 F in vacuum.

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DISCUSSION

Mr. P. N. Randall.[1]—I have two questions:

1. Since the material is being strained beyond the elastic limit, would it not be more accurate to consider strain the independent variable, rather than stress?

2. Have the authors considered calibrating the tester by measuring the strain in the specimen produced by various amplitudes of motion of the permanent magnet?

Mr. G. J. Danek (*author*).—We feel that at high temperatures stress relaxation occurs and static strain measurements would not be representative.

Mr. T. J. Dolan.[2]—One of the problems in operating this type of fatigue testing equipment is that of accurate control of the constancy of the deflection amplitude during cycling. In a number of high-temperature fatigue tests, a change in the damping capacity has been observed and in some cases a change in the elastic modulus of the material with time. It would be very difficult under these conditions to let the electrically excited system operate automatically without frequent attention for readjustment. The author mentioned the possibility of a servo-mechanism being developed for this device, but it is often difficult to obtain the accuracy and stability necessary in such a device. I would also like to suggest that in interpreting the data the author use measured strain instead of calculated stress as a criterion of performance. Such calculations are physically unrealistic and have no real meaning for flexural members operating at high temperatures. The material does not behave elastically; hence the flexure formula is not applicable and gives misleading values that cannot be interpreted in terms of design for members of different size or shape from those of the test specimens. It would be of more significance to study and report the cyclic strain values observed; recent work by Low, Coffin, and others[3] has indicated that *strain* rather than *stress* is probably the important governing parameter.

Mr. Danek.—Concerning servo-mechanisms we do have one in the nearly completed stage. We have been running a few successful tests at various amplitudes with this servo-mechanism.

Mr. C. Harold Ek.[4]—We have had quite a bit of experience in a similar type of test. We have a built-in system which automatically maintains the drive at its own resonant frequency using a magnetic pickup. The vibration of the specimen generates a signal in the pickup which is used in both the driving system and control system to maintain constant amplitude.

Chairman Joseph Marin.[5]—In materials research it is not always appreciated that a very important phase is the development of apparatus and equipment. The problems involved in such developments are not always recognized. I would like to ask the coauthor of this paper, Mr. Achter, if he has any comments to make.

Mr. M. R. Achter. (*author*).—I have just one additional comment to make as to why we do not use static calibration. It has been determined by other workers and confirmed by us that the bending curve in vibration is different from a static bending curve resulting in a difference in stress of 17 per cent. For this reason we have made our stress measurements dynamically instead of in the static manner. Mr. Dolan also mentioned the fact that it would be difficult to hold the amplitude constant throughout the test without a servo-mechanism in the equipment. We have certainly found that in our experience, and that is why we have confined ourselves in this paper to high stress levels where the resonance curve is relatively flat, and we have found that the amplitude remains constant within 1 per cent for perhaps 80 or 90 per cent of the test.

Mr. Frank A. McClintock[6] (*by letter*).—Do the authors have comparable data for stress *versus* cycles to failure for stainless steel in air in the same apparatus?

Messrs G. J. Danek, Jr. and M R. Achter (*authors' closure*).—It was suggested in the discussions by Randall and Dolan that strain rather than stress be considered the independent variable. The authors agree that this is a more realistic approach since the stress calculations employ equations of elasticity. However, no readily available method has been found for obtaining strain values; strain gages are not reliable at the test temperatures used. Methods are presently under consideration to determine the shape of the bending curve of the specimen assembly and from this will be calculated values of strain.

In answer to Mr. McClintock's question, data of this nature are now being taken and will be reported in the future.

[1] Senior Project Supervisor, Engineering Research Dept., Standard Oil Co. (Indiana), Whiting, Ind.

[2] Head, Department of Technical and Applied Mechanics, University of Illinois, Urbana, Ill.

[3] A. C. Low, "Short Endurance Fatigue," International Conference on Fatigue of Metals, The Institution of Mechanical Engineers–American Society of Mechanical Engineers (1956). L. F. Coffin, Jr., "The Problem of Thermal Stress Fatigue in Austenitic Steels at Elevated Temperatures," Symposium on Effect of Cyclic Heating and Stressing on Metals at Elevated Temperatures, Am. Soc. Testing Mats. (1954). (Issued as separate publication ASTM *STP No. 165:*) E. E. Baldwin, G. J. Sokol and L. F. Coffin, Jr., "Cyclic Strain Fatigue Studies on AISI Type 347 Stainless Steel," *Proceedings*, Am. Soc. Testing Mats., Vol. 57, p. 567 (1957).

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A Toric Bending Specimen for Investigation of Geometrical Factors in Fatigue

By J. A. BENNETT and J. G. WEINBERG

A type of plate bending fatigue specimen having an anticlastic surface in the reduced section is described. These specimens can be produced with any desired ratio of edge thickness to center thickness. Preliminary results with these specimens indicate that the presence of a corner on the cross-section of a bending fatigue specimen does not reduce the resistance to fatigue crack initiation, contrary to the results of others. The technique appears to be of possible value for certain types of investigation, and possible improvements are discussed.

IN BENDING fatigue tests of plate or sheet specimens, the cracks have been commonly observed to start at the corners of the cross-section. This naturally led to the conclusion that the resistance to fatigue crack initiation was lower at a corner than on the flat surface of the specimen. A number of investigators (**1-4**)[1] have attempted to evaluate this tendency by comparison of specimens of different shapes, but the results are not consistent, indicating that there are a number of variables which are influencing the results. Some of the factors that might have a bearing on the location of the crack origin are: the lesser restraint to slip in material at the corner; the amount of metal exposed to peak stress; and the effect of the transverse stress present in the surface away from the edge. As a part of an investigation of the mechanism of fatigue crack initiation sponsored by the National Advisory Committee for Aeronautics, it was found desirable to attempt to obtain further information regarding these factors.

Cox and Field (**5**) used a specimen of square cross-section under combined bending and torsion to evaluate the relative resistance to fatigue crack initiation and propagation under shear and direct stresses. The bending moment was applied in such a way that the neutral axis coincided with a diagonal of the cross-section, so the maximum direct stress occurred at the other two corners. The maximum shear stress due to torsion occurred in the middle of each edge, so the relative resistance to shear and direct stress was determined by noting the conditions necessary to shift the crack origin from the corner to a point on the flat surface of the specimen. It appeared that a somewhat similar experiment using direct stress might be devised in order to obtain information regarding the geometrical factors of interest to this investigation.

LIST OF SYMBOLS

- R = radius of curvature of the surface of the reduced section in a plane perpendicular to the length of the specimen.
- b = distance from the longitudinal centerline.
- T_b = thickness at a distance b from the centerline.
- T_e = thickness at edge.
- T_c = thickness at center.
- T_o = thickness at median value of b for origins of non-edge cracks.
- N = number of cycles of stress.
- K_t = theoretical elastic stress concentration factor.
- B = width of reduced section of specimen.

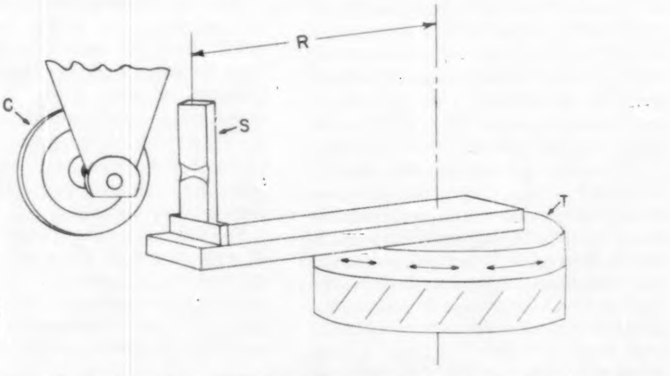

Fig. 1.—Schematic diagram of the milling machine setup for producing the toric surfaces on the specimens. C, milling cutter; S, specimen; T, rotating table on which the specimen is mounted.

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JEROME G. WEINBERG, a graduate of John Hopkins University and the National Bureau of Standards Graduate School, has a B.S. degree in Metallurgy and Chemistry from the University of Alabama. He has approximately 20 years of experience in the field of mechanical metallurgy and is now a mechanical metallurgist in the Atomic Power Division, Pittsburgh, Pa., of the Westinghouse Electric Corp. While at the National Bureau of Standards, he was primarily engaged in basic studies on fatigue of metals.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

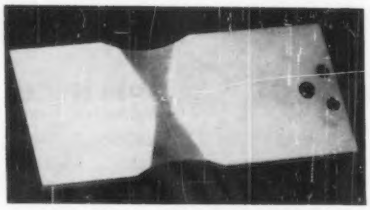

Fig. 2.—(*a*) Specimen as machined. The surface formed by the milling cutter was prepared in order to make it photograph dark, and is not similar to the surface of the specimens tested.

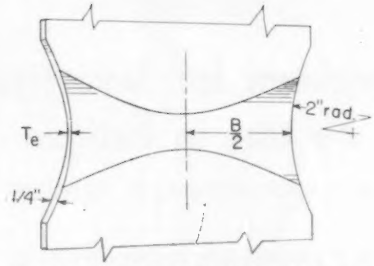

Fig. 2.—(*b*) Reduced section, with dimensions indicated.

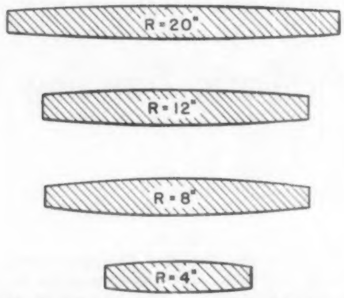

Fig. 3.—Cross-sections of the widest specimens used for each value of *R*.

Specimens and Testing Techniques

The specimens used in the investigation were machined from $\frac{1}{4}$-in.-thick plate and the reduced section was formed by a toric surface on each side. This was produced by mounting the specimen blank so that it could be rotated about a line parallel to its longitudinal axis, as shown schematically in Fig. 1. The center of the rotating table on which the specimen was mounted was on the centerline of a milling machine in which a 4-in. radius cutter was mounted. In this way the cutter milled out a toric surface in the blank having a longitudinal concave radius of 4 in. The transverse convex radius, *R*, could be adjusted (by the position of the specimen on the rotating table) to any desired value up to 20 in. Repeating the cut on the other side of the blank produced a reduced section having maximum thickness in the middle; the thickness at the edge was varied by milling in from the edge of the blank with a 2-in. radius cutter to make a cross-section of the desired width. Figure 2(*a*) shows a completed specimen and Fig. 2(*b*) indicates some of the significant dimensions on a sketch of a reduced section. In order to give a better idea of the shape of the specimens, Fig. 3 shows the minimum cross-sections of the widest specimen used for each value of the transverse radius *R*.

If it is assumed that the neutral axis does not shift as the specimen is bent, then the elastic stress at any point on the surface (neglecting stress concentration) would be proportional to the thickness of the specimen at that point. Figure 4 shows the manner in which the thickness ratio T_b/T_c decreases with increasing distance from the centerline for the four values of *R* that were used.

In addition to the thickness ratio, the stress concentration must be considered in comparing the stress at the edge with that on the surface of the specimen. The graphs in reference (6) for a flat specimen in tension gave values of K_t for the specimens used in this investigation ranging from 1.32 for the widest to 1.12 for the narrowest. It should be noted that the combination of the stress concentration due to the edge notch and the change in thickness of the specimen can produce a rather complicated stress gradient across the specimen. For example, Fig. 5 presents qualitatively the variation in stress ratio that might be expected in a large radius specimen due to these two factors. The effect of stress concentration due to the 2-in. radius notch decreases rather rapidly away from the edge, while the thickness ratio increases slowly. Thus, the actual stress ratio, which would be approximately equal to the product of the stress concentration factor and the thickness ratio, may exhibit a minimum at some distance from the edge.

Values of the reduced section width, *B*, were chosen as the work progressed in an effort to bracket the range where both edge and nonedge cracks were obtained, but for various reasons the results are not as complete as might be desired.

The following combinations of *R* and *B* were used:

R	*B*
20	2.5, 2.0, 1.5
12	2.0, 1.8
8	2.0, 1.6, 1.3, 1.0
4	1.2, 1.0, 0.8

The specimen blanks were cut from 5052-H34 aluminum alloy. After machining they were finished with 600 Aloxite paper on all surfaces of the reduced section, then annealed at 650 to 675 F. Tests were conducted in Krouse plate bending machines with zero mean load. In all but the first few tests, fracture wires were glued to the surfaces of the specimen in order to stop the machine as soon as possible after the initiation of the first crack. To avoid fatigue failure of the wires before a crack formed, the specimens were often run for

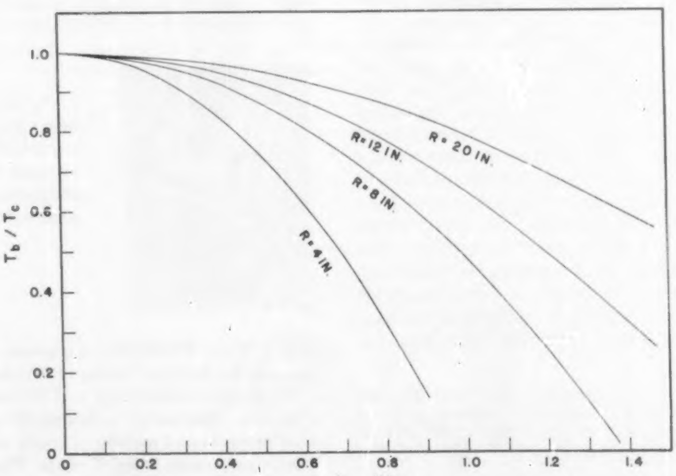

Fig. 4.—Variation of thickness ratio with distance from the longitudinal centerline.

a portion of their expected life before the wires were put on.

No attempt was made to calculate the actual stress amplitude applied to the specimen because of the complicated shape of the cross-section, but the deflection amplitude was varied from specimen to specimen in each group in order to determine whether the results showed any trend depending on stress amplitude. Despite the use of fracture wires, the cracks were usually about $\frac{1}{4}$ in. long when the machine stopped, and in many cases several cracks were found. After the specimens were removed from the fatigue machine they were extended a few per cent in tension. This made it possible to measure the length of the cracks accurately; in specimens containing more than one crack the decision as to which started first was based on the maximum spread of the crack from its origin. In a few specimens the extent of cracking was such that it was not considered possible to make a definite determination regarding the initial crack, and such specimens were discarded. There were two specimens in which an edge crack and a non-edge crack had progressed to very nearly the same extent; as these cracks were not close together, both were recorded. In all other cases it appeared possible to identify the initial crack with a reasonable degree of certainty.

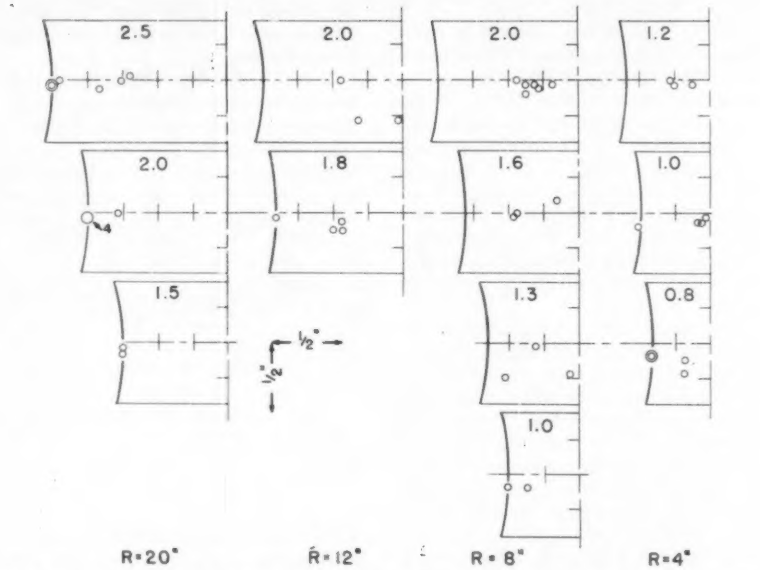

Fig. 6.—Locations of the first crack origins in each group of specimens, relative to the longitudinal and transverse centerlines of the reduced section. The bottom of each chart is toward the clamp end of the specimen. The number at the top of the chart indicates the width, B, in inches for that group of specimens.

Test Results

The location of the origin of the initial crack in each specimen is plotted in Fig. 6, all of the specimens of the same dimensions being shown on a single chart. The origins are plotted in terms of longitudinal position and the distance from the longitudinal centerlines, but no distinction was made between the four equivalent areas of the specimen surface.

To compare the tendency to crack initiation at the edge with that on the nearly flat surface, the stress concentration factor was multiplied by the thickness ratio, T_e/T_c, to give an estimate of the ratio of the stress at the edge to that at the center. As the variation between individual specimens was found to be small, an average value of the ratio was used for all specimens of the same nominal dimensions. Figure 7 shows these values, $T_e/T_c \times K_t$, plotted against the width of the reduced section. Each data point is divided into open or filled areas depending on the proportion of the crack origins in that group which were at the edge. As the number of specimens in each group was not uniform, the area of the circles is proportioned in accordance with the number represented. The results from the widest 8 in. radius

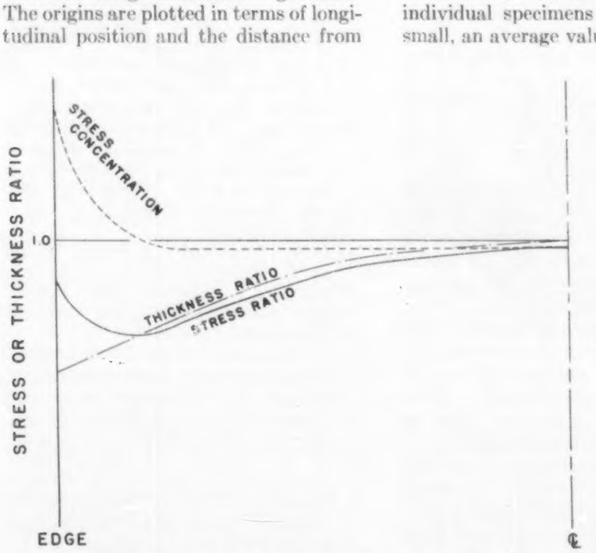

Fig. 5.—Schematic diagram illustrating the factors that influence the stress variation across the reduced section of a large radius specimen.

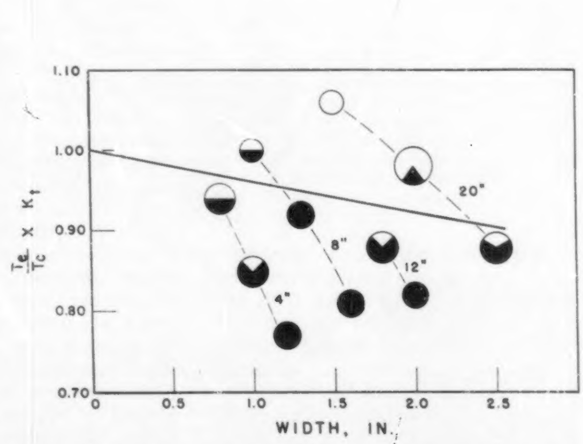

Fig. 7.—The effect of specimen width on the proportion of edge cracks. The area of each circle is proportional to the number of specimens represented, while the fraction of the circle that is filled indicates the proportion of the cracks that originated away from the edge.

specimens are not plotted because the stress ratio was below the range of interest.

While it is rather difficult to draw conclusions from the limited data available, the trend line in Fig. 7 appears to be a reasonable representation of the conditions for 50 per cent probability of edge cracking. This was drawn through unity at zero width to show that the data give no definite indication of a reduction in fatigue strength at the corner of the cross-section. It appears rather that any preference for edge cracking is associated with increasing specimen width.

The plots in Fig. 6 suggest that the location of the non-edge cracks does not depend significantly on the width but only on the transverse radius of the specimen. This observation provides a somewhat different basis for the comparison of edge and non-edge cracking tendencies, using the actual thickness where non-edge cracks started rather than the maximum thickness. Considering the non-edge crack origins in all specimens of the same radius as a group, the median distance from the centerline was determined for each group. The fourth column in Table I lists the thickness ratios at these median distances as a measure of the relative stress necessary to initiate non-edge cracks. Comparison of these values with the values of $T_e/T_c \times K_t$ for each group of specimens should indicate whether a smaller stress is required to start a crack at the edge or away from it. The last column of Table I shows that the probability of edge and non-edge cracking is essentially the same.

TABLE I.—COMPARISON OF STRESS NECESSARY TO INITIATE EDGE AND NON-EDGE CRACKS.

R,[a] in.	B,[a] in.	$T_e/T_c \times K_t$[a]	T_o/T_c[a]	Smaller Stress for
20....	2.5	0.88	0.88	(Equal)
20....	2.0	0.98	0.88	Non-edge
12....	1.8	0.88	0.94	Edge
8....	1.0	1.00	0.93	Non-edge
4....	1.0	0.85	0.97	Edge
4....	0.8	0.94	0.97	Edge

[a] See list of symbols.

As indicated in Fig. 5, the stress ratio in a large radius specimen probably drops rather rapidly away from the edge, and this explains the fact that there is a region in these specimens where no cracks started. However, there was one specimen (top left in Fig. 6) in which the crack started only $\frac{1}{16}$ in. from the edge. Careful inspection of this fracture left no doubt that the origin was away from the edge and there was no observable defect that might have been responsible for the weakness at this point. Consequently, this also must be taken as an indication that the corner of the cross-section does not necessarily have a much lower resistance to fatigue than a flat surface.

It is of interest to determine if there was any correlation between the number of cycles to failure and the probability of edge cracking, as this would indicate whether or not the factors influencing the location of the origin were affected by the magnitude of the applied stress amplitude. To do this, all specimens from groups that had both edge and non-edge cracks were considered together, with the following results:

Crack Initiation	Number of Specimens	Number of Cycles to Failure, 10^3		
		Minimum	Median	Maximum
Edge.......	8	188	1520	1848
Non-edge...	10	37	475	3692

There is apparently a greater tendency for cracks to initiate at the edge when the stress amplitude is small (larger number of cycles to failure), but the effect is not very consistent.

It is evident in Fig. 6 that the location for maximum probability of crack initiation away from the edge does not coincide with the maximum thickness, as would be expected, but lies away from the centerline by a distance that appears to increase with increasing values of R. This suggests that the transverse stress in the middle of the specimen increases the resistance to fatigue, and such a conclusion would be consistent with the negative slope of the trend line in Fig. 7. However, the transverse stress would increase with increasing width for specimens of any one radius, and if the above hypothesis is correct there should be a tendency for the crack origins to lie farther from the centerline in the wider specimens. As no such tendency is apparent in Fig. 6, the hypothesis is somewhat questionable.

Corten and Dolan (**3**) attributed the differences which they found in the fatigue strength of different shaped specimens to two factors, namely, the weakening effect of a corner and the decrease of strength with increase in the amount of material exposed to peak stress. As stated previously, the present data do not support the conclusion that a corner results in lower fatigue strength. Also, the negative slope of the trend line in Fig. 7 is contrary to what would be expected from a consideration of the amount of material exposed to peak stress. While these results are of a preliminary nature, the contradiction with results by other techniques makes it evident that considerably more experimental and theoretical work is necessary before all of these factors can be resolved. The experimental technique described here should be of considerable value in solving these problems. Additionally, it could be used to investigate a wider range of variables by changing the radius and included angle at the corners of the cross-section.

As the work progressed, it became obvious that certain changes would have made this technique more useful. In particular, it would be helpful if the stress at any point on the surface of the specimen could be reliably calculated. This would be easier if the specimen were made with "streamline" fillets in order to reduce the longitudinal stress concentration to a negligible value and also if the specimen were loaded in pure bending rather than as a cantilever.

Conclusions

1. A bending fatigue test specimen having an anticlastic surface in the reduced section may have utility in certain types of investigation.

2. Results with annealed 5052 aluminum alloy, using this type of specimen, indicate that the lack of restraint at the corner of a cross-section does not significantly reduce the resistance to fatigue crack initiation.

3. The transverse stress in the middle of a wide plate apparently increases the resistance to fatigue crack initiation, and

4. In groups of specimens of the same shape, those tested at low stress amplitudes showed a greater proportion of edge cracks than those tested at high stress amplitudes.

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High-Temperature Fatigue Testing—with Application to Uranium*

By JACK R. BOHN and GLENN MURPHY

Fatigue testing at elevated temperatures presents difficulties when the material is subject to oxidation. Various test techniques are discussed in this paper, and two methods of protection, plating and encasing the specimen in a flexible envelope, are considered in particular. Equipment for encasement is described. Results of tests on uranium at temperatures up to 600 C in repeated flexure indicate that the encasement method is superior to other techniques of protection. The method is not time-consuming and the scatter of test data is reduced markedly in comparison with data from specimens protected by other means.

In obtaining information concerning the mechanism of failure and in evaluating the resistance of a material to failure, it is frequently desirable to obtain data over a wide range of temperatures. If the material is subject to oxidation within the temperature range involved, protection must be provided; this is particularly important where long-time endurance or creep tests are being run.

To prevent oxidation of a material under test, an oxygen-tight barrier must be interposed between the specimen and the oxygen-containing atmosphere. The barrier may be placed (1) on the surface of the specimen; (2) surrounding, but not in intimate contact with the test section; or (3) surrounding the testing machine.

The first two methods were studied in the investigation reported in this paper. The third method was considered less promising from both the standpoint of initial cost and operating problems.

Surface Barriers

At temperatures below 200 C, little difficulty is experienced in finding suitable paints or coating materials that are easily applied, adhere satisfactorily, and are adequately oxygen-resistant. No such coatings were found suitable for temperatures above 400 C.

Electroplating was investigated for the specific problem of protecting uranium at temperatures above 300 C in rotating-beam fatigue tests. Copper, nickel, and silver, alone and in various combinations, were used as the plating materials. No particular difficulty was experienced in electroplating these materials on standard 0.252-in. diameter rotating-beam specimens. The plating adhered loosely, minimizing intermetallic diffusion, but was not satisfactory for two reasons. One difficulty was that the endurance limit of the material added was less than the endurance limit of the uranium, with the result that the plating cracked at a relatively small number of cycles at the stress levels involved. This permitted oxygen to enter the specimen and rapid oxidation ensued. The second difficulty stemmed from the fact that oxygen diffused through the coatings into the specimens.

Some improvement was achieved by applying alternate coatings of two or more metals, with each coating in the order of 0.001 in. in thickness. Coverage was improved and permeability decreased by polishing each surface between coatings. However, a maximum of a few million cycles of loading was about all that could be expected before the coatings failed. Consequently, the evaluation of the endurance limit involved the application of a coating, running the specimen for a few million cycles, stripping the coating, replating, and repeating the procedure.

Check tests at room temperature indicated that the interruption of the cycling for stripping and replating had no measurable effect upon the endurance limit. However, the procedure was time-consuming and was abandoned in favor of encapsulation of the specimen.

Encapsulation

The method of protection developed involves encasing a slightly modified 0.252-in. diameter fatigue specimen in a flexible capsule capable of withstanding cyclic stress and exposure to the atmosphere at high temperatures. The flexible capsule consists of a section of bellows welded to two lengths of tubing. The capsule is fabricated around the specimen in an argon atmosphere; thus argon is sealed in the capsule with

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GLENN MURPHY has been at Iowa State College since 1932 in the Department of Theoretical and Applied Mechanics, and has been head of the department since 1955. He is also Senior Engineer in the Institute for Atomic Research associated with the Ames Laboratory of the AEC. He is chairman of the newly organized ASTM Administrative Committee on Education in Materials.

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* Presented at the Nuclear Engineering and Science Conference, March 17–21, 1958, Chicago, Ill.

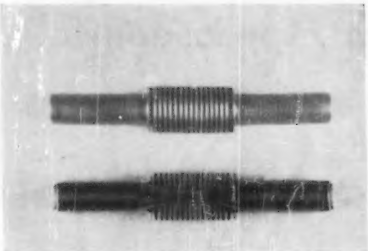

Fig. 1.—Flexible capsule and a sectioned assembly.

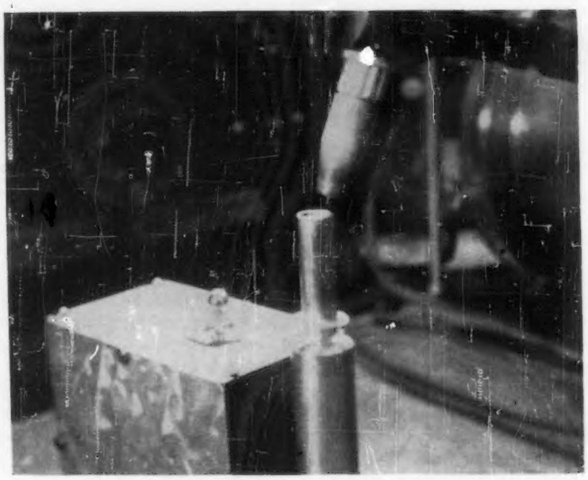

Fig. 2.—Welding an end cap to a flared tube.

the specimen. Figure 1 is a photograph of an encapsulated specimen and a sectioned assembly indicating the specimen contained in its capsule.

Fabrication of the capsule is accomplished readily by shielded-arc welding techniques, using special jigs and fixtures. Type 310 stainless steel thin-wall tubing (0.500-in. outside diameter by 0.018-in. wall) is cut into $1\frac{9}{16}$-in. sections. (The metal cutoff saw was found to be an effective means of sectioning the tubes.) One end of each section is flared in a spinning operation to a diameter of $\frac{3}{4}$ in. The spinning is accomplished in a lathe using a brass tool held in the compound rest while the tube rotates in a special collet in the headstock. Several minor forming operations are also necessary to introduce a slight taper in the flared end of the tube.

The ends of the capsule are punched and formed from 0.020-in. type 310 stainless steel sheet in a simple hand-operated die. The flexible portion of the capsule is a stainless steel seamless bellows 0.500-in. in inside diameter by $\frac{3}{4}$ in. in outside diameter by $1\frac{1}{4}$ in. long, with 16 active convolutions. The end convolutions of the bellows are separated from the adjacent ones, and half of each ground off and formed to match the flare of the tube.

After forming, each piece is etched at 60 C using a chemical etch containing by volume 25 parts nitric acid, 350 parts hydrochloric acid, and 625 parts water. Pieces are then scrubbed with a commercial household scouring powder and rinsed with distilled water. The 0.252-in. fatigue specimen varies from the standard specimen only in that its shoulders are machined to a diameter of 0.466 in. instead of 0.500 in. The test section of the specimen is carefully machined and polished in accordance with standard techniques.

The end caps are welded (heli-arc) to the unflared end of the tubes. A special jig was constructed which rotates the work (speed variable) while the torch is held stationary. Figure 2 shows the setup for this operation.

The capsule tubes are pressed onto the shoulders of the specimen. The diameter of the shoulders is 0.001 in. larger than the inside diameter of the tube to insure good mechanical coupling between the specimen assembly and the fatigue machine collets. The bellows, in a slightly compressed state, is contained in the midsection. As such, the assembly is ready to be joined and sealed in a welding chamber specially designed for this purpose.

Welding Equipment

The power supply is an X R-10X Miller electric welder rated at 1.5 to 15 amp dc. It is connected in parallel with a Miller high-frequency arc starter. In this remote application the high frequency is necessary to facilitate starting the arc without touching the electrode to the work. A time-delay circuit in the welder provides maximum current (15 amp) before and for $\frac{1}{10}$ sec after the arc is started. This and the use of thoriated tungsten electrodes (20-mil) provide additional aid in starting the arc. Welding the 0.005-in. bellows to the 0.015-in. flange requires approximately 2 amp. A foot switch controlling the high frequency supplies the triggering action which starts the d-c arc. A block diagram of the apparatus is given in Fig. 3, and an over-all view is shown in Fig. 4.

The welding chamber is a brass tube 6 in. in diameter mounted parallel to its longitudinal axis with a sight glass access port on one side and power connections on both ends. A single con-

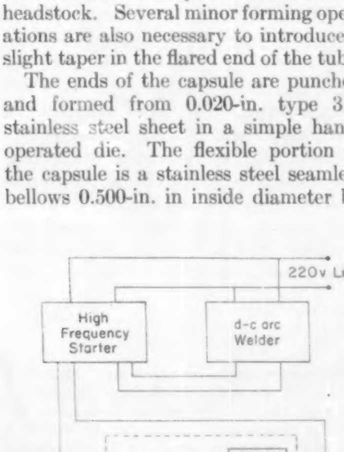

Fig. 3.—Block diagram of apparatus.

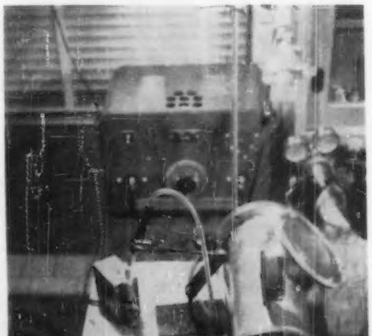

Fig. 4.—View of welding equipment.

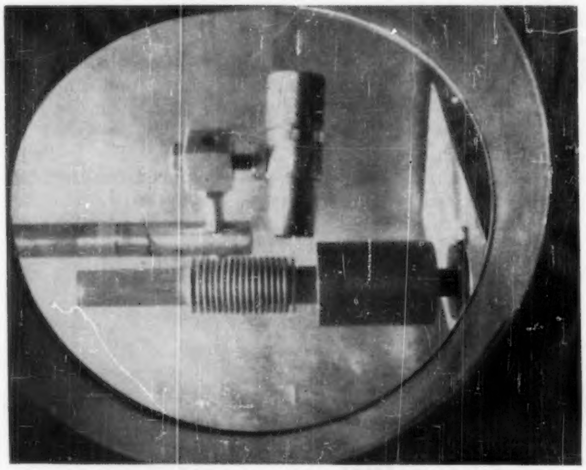

Fig. 5.—Sealing the capsule in the weld chamber.

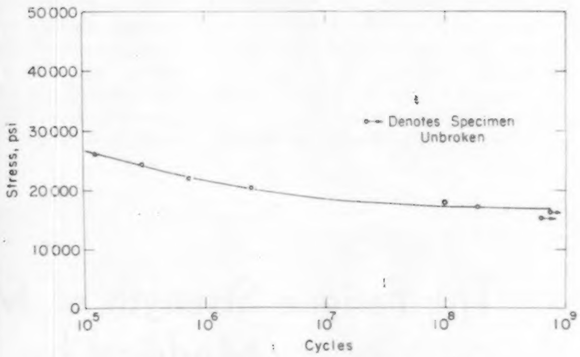

Fig. 6.—*S-N* diagram for natural uranium at 300 C.

nection to a "Y" fitting provides the facilities for evacuating, purging, and venting the system. Power connections for the work and the electrode are insulated from the chamber using Plexiglas disks which constitute the ends of the chamber. The work and the electrode connections may be changed end for end to accommodate pieces varying in length. The electrode support is a brass rod ½ in. in diameter which passes through the Plexiglas end plate by means of a rotating seal mounted in brass fittings, enabling both translational and rotational movement of the electrode. The electrode holder is offset from the main rod support. The holder offset is adjustable to accommodate work of varying diameters.

The work end of the chamber consists of a fractional horsepower motor and a variable speed-reducer mounted eccentrically on the end plate. It was necessary to seal the fractional horsepower motor to permit evacuation of the chamber without excessive outgassing. A mechanical forepump is used to evacuate the system. Usually about ½ hr is required to obtain pressures consistent with the impurities of the purging gas (several microns of mercury) and the capacity of the pump. Argon gas is used in preference to other commercially available inert gases because of its lower impurity content and superior arc stability characteristics.

Collets which secure the work are driven by the speed reducer at speeds of ½ to 3 rpm. Experience with hand-driven models has proved this the most useful range. The electrode is held as close as possible ($\frac{1}{32}$ in.) to the work, depending upon the amount run out in the work as it rotates. For maximum uniformity in the weld bead the electrode is held at an angle of approximately 15 deg from the vertical so the melt travels up the arc. A notching effect is produced in the bead unless the melt is made to travel uphill. For any particular piece with a given diameter and thickness, accurate welding control can be accomplished by varying the current and the speed of rotation. This feature has made the apparatus a useful tool for many laboratory applications.

Discussion of Variables Introduced by the Technique

Calculations were made to evaluate the resisting moment developed by the flexible capsule relative to the specimen. This is significant in determining the actual stress to which the specimen was subjected. A direct analytical method of correlating the relative moments is not possible due to the variation of cross-section for both specimen and capsule as a function of distance along the longitudinal axis; hence a graphical method was used. It was found that the moment developed by the capsule is about 0.1 per cent of the total resisting moment. Therefore, the effect of the capsule on the stress in the specimen may be neglected.

A change in temperature in the argon gas sealed in the capsule is accompanied by a change in pressure, resulting in an axial tensile stress which is transferred through the specimen. The magnitude of the tensile stress is approximately 160 psi for a temperature change from 25 C to 600 C. Elimination of the effect is possible by several methods, imposing serious restrictions on the welding techniques.

Sealing the capsule at sufficiently low pressures would produce a balance in the external and internal pressures on the assembly under test conditions. For the example mentioned, the reduced sealing pressure would be on the order of 5 psia. Experimentation indicated this approach to a solution to be impractical. The effect on specimens run at varying temperatures could be made constant by increasing the internal gas pressure accordingly at the lower testing temperatures. Welding (sealing) under increased pressures would be possible.

In general, the effect of the increasing gas pressure with increasing temperature is significant only at high temperatures, where flexural stresses will probably be low. There is the possibility that such an effect, if controlled, could be useful in particular fatigue studies.

In press fitting the capsule tube onto the specimen a short-time compressive stress is introduced in the specimen. The magnitude of the stress (1500 psi) did not seem to warrant consideration relative to the history of the material.

Scatter

Scatter in the data obtained from specimens tested in flexible capsules was low compared to that obtained by other means, even in comparison with data obtained at room temperature. Specimens are being run to provide statistical support for observation regarding scatter. Because of low scatter, fewer specimens are required to determine the fatigue properties of a completely unknown material. This point is illustrated by the *S-N* diagram (Fig. 6) requiring only eight specimens. Current interest in the relatively scarce and expensive materials for high-temperature application makes this fact worthy of consideration.

Protection

Only in a few instances has a flexible capsule failed to provide the necessary protection from oxidation for a specimen.

In these instances, early in the investigation the fault was found to be pinhole leaks in the welds. No instances have been encountered where fatigue of the seamless bellows was responsible for failure nor was the bellows ever ruptured upon fracture of the specimen. The surface condition of a specimen when removed from its capsule is as good as it was when it was sealed.

The method of protection is limited temperature-wise only by the temperature restrictions of the material used in the construction of the capsule and the testing machines. Type 310 stainless steel is used because of its resistance to scaling, allowing the ready removal of capsule assemblies from fatigue machine collets and fixtures, especially after long-time (3 or 4 months) elevated temperature tests (600 C). Inconel was considered for operation up to 1000 C.

Conclusions

From the investigation reported it is concluded that encapsulation is a practical and effective method for the protection of materials to be tested at elevated temperatures. The bellows type of capsule described has excellent characteristics for use with rotating-beam fatigue specimens in affording protection for 4-month periods at 600 C.

The Fatigue Strength of Magnesium Alloy HK31 as Modified by a Weld Joint

By J. E. BREEN and ARTHUR S. DWYER

The fatigue strength of welded magnesium alloy HK 31-H24 was tested in reverse bending and compared to that for the "as-rolled" HK31 sheet stock. The fatigue strength of the welded sheet is 40 to 45 per cent that of the original stock. The fatigue strength can be raised to between 50 and 60 per cent of the original stock by putting fillets in the weld bead, or to 80 to 90 per cent of the original stock by sanding the weld bead flush with the rest of the surface. The change in fatigue strength is primarily controlled by the weld-bead geometry and the resulting generation or elimination of notches.

Engineering requirements on modern equipment, especially that used on aircraft, demand the efficient use of available materials. Often the design engineer must design on the basis of incomplete information if he wishes to use the most recent developments of metallurgists and materials engineers. It was the intention of this investigation to provide data on welded specimens and hence a better understanding of welded structures made of magnesium alloy, HK31, subjected to fatigue loading.

As-rolled, $\frac{1}{8}$-in. sheet stock was used in this investigation. The fatigue curve for the material was established and found to agree with published data. Welded sheet was then cut into specimens and the modification of the fatigue strength due to the weld was determined.

Test Procedure

Standard "Krouse type" fatigue specimens, as shown in Fig. 1, were tested in reverse bending.

Sheets of the HK31 alloy, $\frac{1}{8}$-in. thick, were welded using standard techniques for magnesium alloys (shielded arc with HK31 welding rod—weld cleaned with wire brush). Specimens were cut such that the weld ran through the middle of the specimen. In most cases the weld ran perpendicular to the axis of the

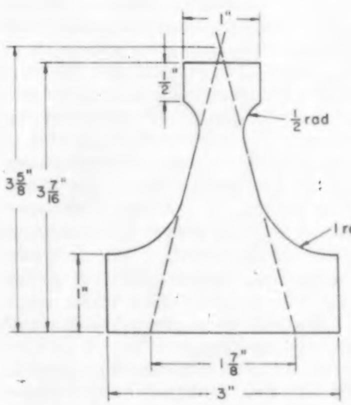

Fig. 1.—Krouse type fatigue specimen.

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ARTHUR S. DWYER, head, Metallurgy Group, Consulting Section, Wayland Laboratory, Raytheon Manufacturing Co., is a graduate of M.I.T. One of his chief fields of interest is the strength of structures and the manner in which metallurgical and environmental variables affect these. He has authored several papers on the properties of magnesium alloys.

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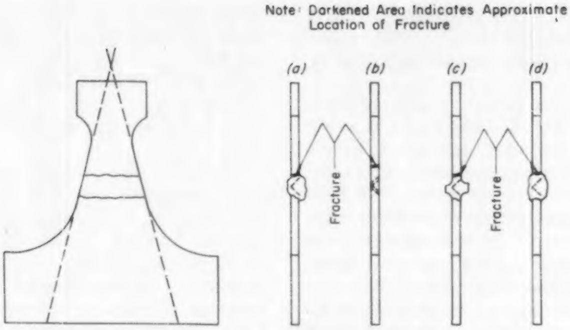


Fig. 2.—Test specimen with weld perpendicular to specimen axis.
(a) Welded on one side only—Series A. (b) Weld sanded flush with surface of specimen—Series B. (c) Weld contoured to have fillets—Series C. (d) Welded on two sides—Series D.

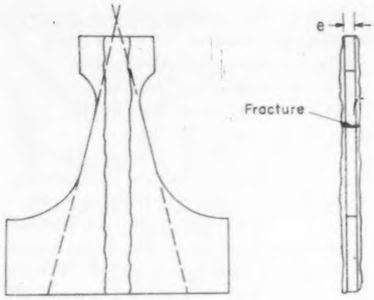


Fig. 3.—Test specimen with weld parallel to specimen axis. Welded on one side only—Series E.

specimen (Fig. 2). One series, however, was cut with the weld parallel to the axis of the specimen (Fig. 3).

Five series of tests, in addition to the initial series on the virgin material, were run as follows:

1. *Series A.*—Weld perpendicular to axis of specimen; welded on one side only; tested in the "as-welded" condition (Fig. 2(*a*)).
2. *Series B.*—Weld perpendicular to axis of specimen; weld sanded flush with the surface of the specimen (Fig. 2(*b*)).
3. *Series C.*—Weld perpendicular to axis of specimen; weld contoured to provide fillets (Fig. 2(*c*)).
4. *Series D.*—Weld perpendicular to axis of specimen—welded two sides; pass with welding electrode on bottom of weld as light as possible and used only to fuse the surface (Fig. 2(*d*)); and
5. *Series E.*—Weld parallel to axis of specimen (Fig. 3).

As can be seen from the above program, the study was primarily one of weld geometry and its relation to notch effect in this particular alloy.

Results and Discussion

An initial series of tests were made on the sheet material to determine how closely our results would agree with values obtained from other sources. The results are shown in Fig. 5(*a*). These data fall in the scatter band of a fatigue curve furnished by Dow Chemical Co.[1] for reverse bend tests on this material. Thus a satisfactory base line was assured which could be used as a criterion to which all other values could be compared.

It was felt that there were two ways that a weld might affect the strength of the base material. The heat dissipated by the deposited metal may modify the metallographic structure and hence the mechanical properties in the heat-affected zone. Secondly, the weld will modify the geometry of the piece giving rise to notches which may serve as stress concentration points. Both of these factors are operative, as can be seen from the results of the tests given in Fig. 5 (*b*)–(*f*).

Figure 5(*b*) shows the results on the specimen that had a simple weld (series A). It shows that in structures subjected to fatigue-type loading and containing welds the working stress must be lowered well below that for the base value for HK31 alloy.

Firure 5(*e*) (series D Fig. 2(*d*)) shows that these results are little affected by fusing the base of the weld on the reverse side of the specimen.

Figure 5(*f*) (series E, Fig. 3) shows that these results are little affected by the direction of the weld. The fatigue life of the specimen is about the same with the weld parallel or perpendicular to the specimen axis. The exact determination of the section modulus for the series E specimens is difficult. Both the moment of inertia and the distance from the neutral axis to the outer fiber are variable and larger than in the other specimens. This results in a slight error in calculating the stress, which is probably higher than that reported here. The notch effect is produced by irregularities in the weld bead and not by the edge of the bead meeting the surface of the specimen as in the other cases. However, for a given imposed bending

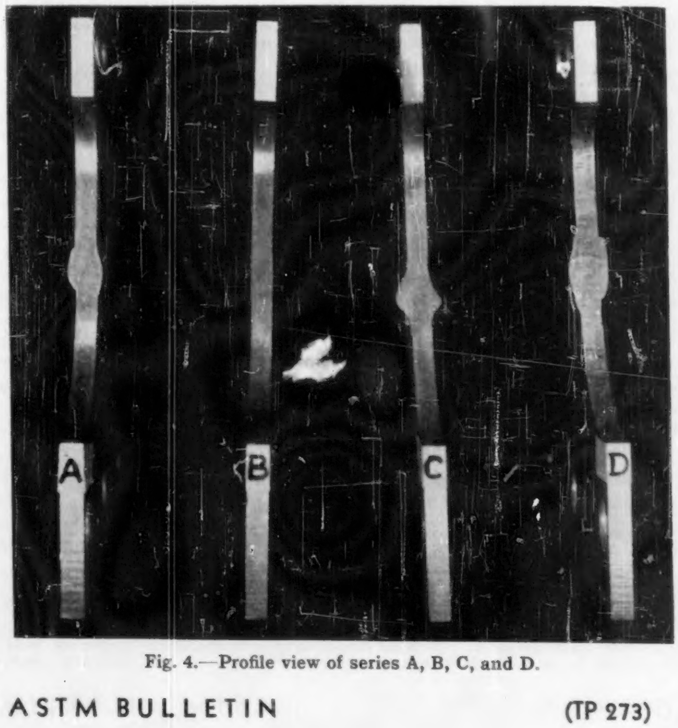


Fig. 4.—Profile view of series A, B, C, and D.

[1] Dow Chemical Co., "HK31XA Magnesium Alloy, Sheet and Plate (interim data)," 16 Feb., 1956, revised 14 June, 1956.

moment, the fatigue life in reversed bending is the same.

Figure 5(*c*) gives the results on a series of welded specimens in which the weld had been sanded flush with the surface of the specimen (series B). This series while having less fatigue strength than the base material had considerably more fatigue strength than any other series of welded specimens. A word of caution should be added here. This procedure of sanding the weld flush with the surface puts a greater premium on good welding than leaving the weld bead as deposited. Any welding defect will have a much greater effect in lowering the fatigue strength in this case. It is the opinion of the authors that sanding the weld bead flush is the best condition in which to leave the weld. However, if this procedure is to be followed, the authors feel that so great is the need for good welding that all welds must be subjected to 100 per cent radiographic inspection.

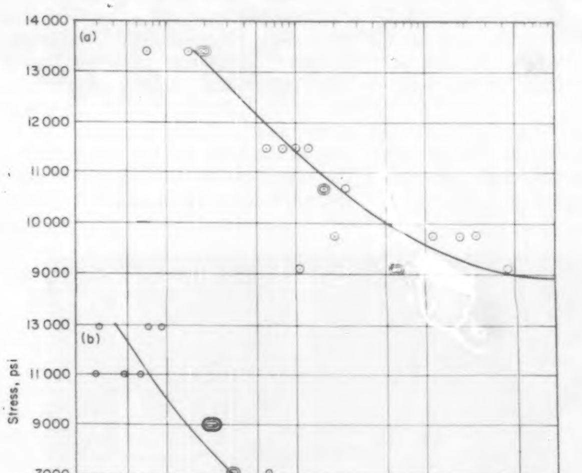
Examination of the various specimen profiles in Fig. 4 shows that the specimens with the weld bead left on have a sharp, almost square, notch where the weld bead meets the metal. All fractures originated at these positions without exception. This is further evidence that the notch was the governing factor in lowering the fatigue strength of this series of specimens. Work by Lessells and Associates, Inc.,[2] on notched specimens of HK31 in standard rotating-beam fatigue tests showed that the endurance limit of the notched material was only about 60 per cent of that for the unnotched material. This would give the alloy HK31 the rather high notch sensitivity of 0.734.[3] Using this value for notch sensitivity and calculating back in the formula to find K_t (the stress concentration factor) for the as-deposited weld beads, it can be shown that K_t is approximately 3.3 for this case.

The specimens on which the weld bead had been sanded flush with the specimen surface (Fig. 2(*b*)) fractured near but outside the weld. Other investigations at Raytheon indicate that the tensile strength of magnesium alloy HK31 as a function of solution temperature goes through a minimum at an intermediate solution temperature.[4] In the welded fatigue specimens there is a zone in the heat-affected area which passes through this temperature during the welding process, and in the absence of a notch this zone acts as the weakest link.

[2] Lessells and Associates, Inc., *Technical Report No. 586/C37*, 11 Dec., 1956.

[3] For explanation of notch sensitivity see Manual on Fatigue Testing, Am. Soc. Testing Mats., p. 5 (1949). (Issued as separate publication *ASTM STP No. 91*.)

[4] Raytheon Manufacturing Co., "Static Properties of Magnesium Alloy HK31," to be published.



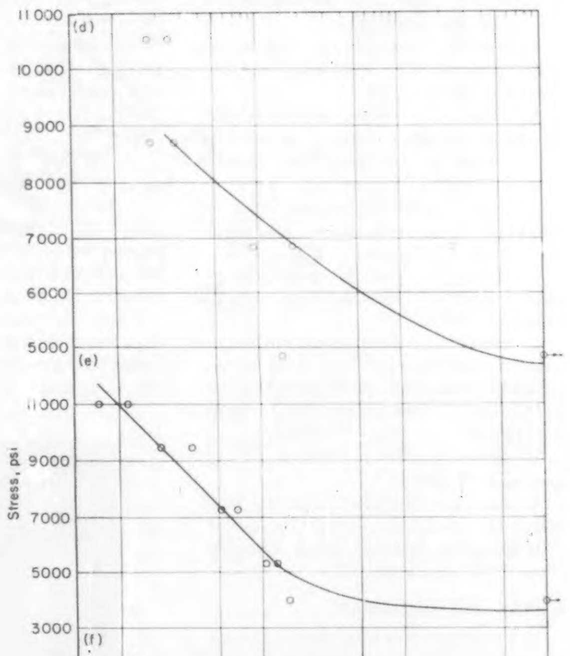


Fig. 5.—Fatigue curve on magnesium alloy HK31-H24.

(*a*) In the "as-rolled" condition. (*b*) Weld bead left as-deposited weld one side only—Series A. (*c*) Weld sanded even with specimen surface—Series B. (*d*) Weld contoured to have fillets on both sides—Series C. (*e*) Weld two sides, weld left as-deposited—Series D. (*f*) Weld parallel to specimen axis—Series E.

To round out the investigation, a series of fatigue tests (series C) were run in which the weld bead on the specimen was contoured such that the sharp notch noted on the specimens in the earlier tests was replaced with fillets (Fig. 2(c)). The results of this series are shown in Fig. 5(d). The fatigue strength of the contoured welds is intermediate between those in which the weld was sanded flush and those in which the weld was left as deposited.

Conclusions

The fatigue strength of magnesium alloy HK31-H24 is lowered by the presence of a weld in the piece. The magnitude of this lowering is primarily a function of the weld geometry and, to a lesser extent, a function of solution temperatures produced in the heat-affected zone during the welding process.

The following general statements can be made:

1. Welds that have been sanded flush with the surface of the specimen have a fatigue strength approximately 80 to 85 per cent of the HK31 sheet stock.
2. Welds that have been contoured to put a fillet in the weld bead have a fatigue strength approximately 50 to 60 per cent of the HK31 sheet stock.
3. Welds in which the weld bead is left "as-deposited" have a fatigue strength 40 to 45 per cent of the HK31 sheet stock; and
4. The approximate fatigue strength in reversed bending at 10^7 cycles of HK31-H24 is as follows:
   (a) In the as-rolled stock, 9600 psi,
   (b) welded with the weld sanded even, 7600 psi,
   (c) welded with the weld filleted, 5600 psi, and
   (d) welded with the weld left as deposited, 3900 psi.

Acknowledgment:

The authors wish to thank Wendell Carlson for reviewing the manuscript and R. A. Howard who ran the fatigue tests.

A Note on the Effect of Pressurization on the Fatigue Life of Metals

By L. W. HU

It is a well established fact that the surface condition and the internal stress are two of the factors having great effects on the fatigue strength of metals. In order to increase the fatigue strength of structural and machine members, favorable internal stress systems may be deliberately induced in the parts by either cold working or thermal processes (**1**).[1] Studies have been made in correlating the distribution of the internal stress with its influence on the fatigue life of metals. It is reasonable to believe that each method employed will give a characteristic pattern of residual stresses induced. Therefore, one method may prove to be more desirable than the others in a particular case. Surface rolling is one of the industrial methods used to improve the fatigue strength of machine parts by cold working (**2**). In this process, contact pressure of high intensity is used so that the surface rolling may produce plastic deformation in the surface layer of the material while the core is not affected. By this method a preferable state of residual stress in the machine parts is achieved. The smoothness of the surface of the material may also be improved by the surface rolling process. Instead of contact pressure as employed in surface rolling, it was thought interesting to investigate the effects of the application of hydrostatic pressure.

Due to the defects and impurities in the crystal lattice as well as the geometrical configuration of its structure, single crystals are elastically anisotropic. Many investigations have been made to examine such anisotropy since Cauchy made his study (**3**). In many cases polycrystalline materials are considered to be elastically isotropic because the crystals in the aggregate are small and randomly orientated. However, shear stresses will be produced in the crystals if the material is subjected to hydrostatic pressure of high intensity because of the random orientation and elastic anisotropy. It is believed that the shear stress so produced may be relieved when yielding occurs in the crystals. Consequently, a small amount of deformation may be produced by the pressurization. Therefore, it is conceivable that the fatigue strength of metals may be affected after being exposed to hydrostatic pressure of high intensity.

In this paper, a preliminary investigation on the effect of pressurization on the fatigue life of two materials is reported.

Material Tested

In this investigation, fatigue tests of rotating-beam type were conducted on the following two materials:

Aluminum Alloy 2017-T4

The nominal chemical composition of the aluminum alloy 2017-T4, in addition to aluminum and nominal impurities, consisted of 3.5 to 4.5 per cent copper, 0.8 per cent silicon, 0.2 to 0.8 per cent magnesium, 0.4 to 1.0 per cent manganese, 1.0 per cent iron, 0.1 per cent zinc, and 0.25 per cent chromium (**4**). The typical mechanical properties given by the manufacturers were: tensile strength 62,000 psi, fatigue strength for 500×10^6 cycles 18,000 psi. The hardness of the material was found to be about Rockwell hardness B 44.

Carbon Steel C1045

The nominal chemical composition of the carbon steel C1045, in addition to iron and nominal impurities, con-

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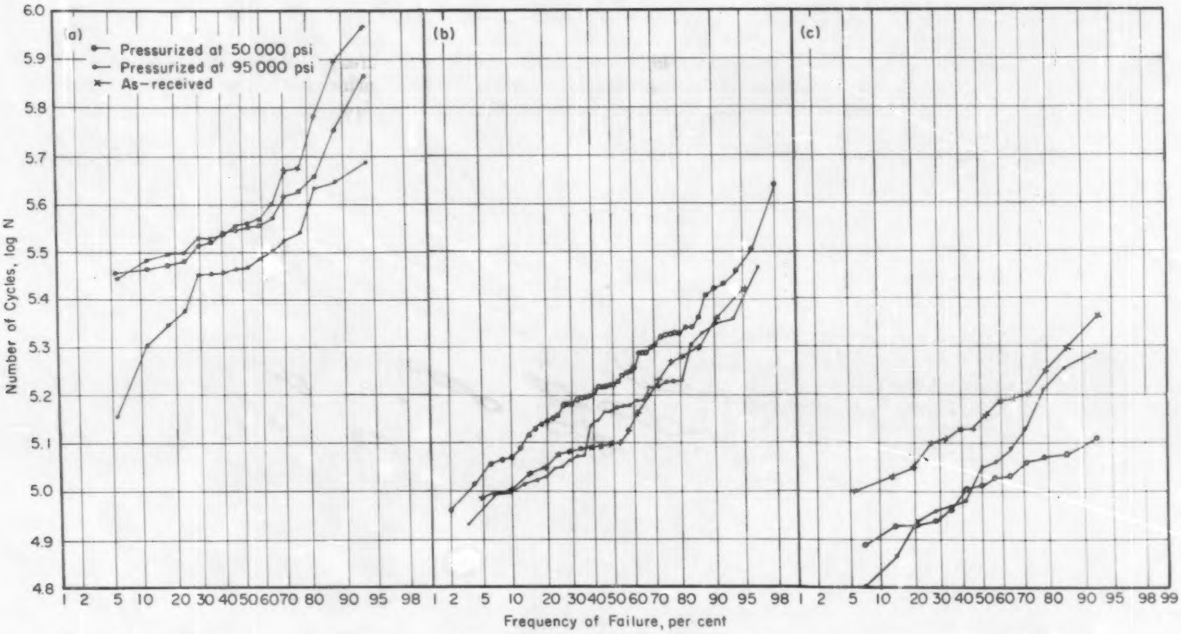
[1] The boldface numbers in parentheses refer to the list of references appended to this paper.



(a) Aluminum alloy 2017-T4—series 1. (b) Aluminum alloy 2017-T4—series 2. (c) Steel C1045.

Fig. 1.—Results for age-hardened aluminum alloys and carbon steel.

sisted of 0.40 to 0.50 per cent carbon and 0.60 to 0.90 per cent manganese. The Rockwell hardness of the material received was found to be about B 80, the tensile strength, about 72,000 psi.

Specimen and Testing Machine

The specimens, of modified R. R. Moore type, were made by the Ann Arbor Instrument Co. and were refinished and repolished after receipt. For repolishing the specimens, No. 240 emery cloth was used first, followed by No. 320 emery cloth, No. 500 emery cloth, crocus cloth, and finally the buffing wheel. In many cases, the first two steps were found unnecessary. Repolishing was discontinued when no scratches or tool marks were visible in the testing section. Then the diameter of the specimen at the testing section was measured with great care to avoid scratching or indenting the specimen. For the aluminum specimens tested, the average diameter at the test section was found to be 0.299 in. and the maximum and minimum values were found to be 0.302 in. and 0.294 in. respectively. For the steel specimens tested, the average diameter at the test section was found to be 0.300 in., and the maximum and minimum values were found to be 0.302 in. and 0.299 in. respectively.

An R. R. Moore high-speed fatigue testing machine manufactured by the Baldwin-Southwark Corp. was used to conduct the fatigue tests. This rotating beam type machine has a maximum speed of 10,000 cpm.

Testing Procedure

Since it was probable that the specimens were not made from the same bar stock, all specimens for each series of tests were randomly arranged after being received. After they were repolished, all specimens were randomly divided into three groups and then numbered accordingly. One group was tested without exposure to hydrostatic pressure. The second group was tested after the specimens were exposed to hydrostatic pressure of about 50,000 psi for 3 to 5 hr. The third group was tested after the specimens were exposed to hydrostatic pressure of about 95,000 psi for 1 to 2 hr. High-pressure equipment used to pressurize the specimens is described in references (**5**) and (**6**). The pressure medium was a XCT White Oil (formula 3250) supplied by the Esso Standard Oil Co.

The fatigue life of aluminum specimens subjected to an alternating bending stress of 38,000 psi and that of steel specimens subjected to an alternating bending stress of 70,000 psi were determined and recorded. Such comparatively high stress levels were chosen because, in addition to the time-saving consideration, it is known that the distribution of fatigue life at a high stress level may approach a normal distribution.

TABLE I.—COMPARISON OF MEAN FATIGUE LIFE OF ALUMINUM ALLOY 2017-T4 AND STEEL C1045.

	Aluminum Alloy 2017-T4—Series 1			Aluminum Alloy 2017-T4—Series 2			Carbon Steel C1045		
	Number of Specimens Tested	Mean Fatigue Life, 10^5 cycles	Per Cent Change Due to Pressurization	Number of Specimens Tested	Mean Fatigue Life, 10^5 cycles	Per Cent Change Due to Pressurization	Number of Specimens Tested	Mean Fatigue Life, 10^5 cycles	Per Cent Change Due to Pressurization
As received	16	4.102	...	20	1.408	...	16	1.423	...
Pressurized at 50,000 psi	16	3.773	−8.0	49	1.740	+23.6	16	0.993	−30.2
Pressurized at 95,000 psi	16	2.950	−28.0	30	1.432	+1.7	15	1.096	−23.0

Results and Discussion

Test results for two series of age-hardened aluminum alloy 2017-T4 and carbon steel C1045 are shown in Fig. 1 in which the frequency of failure is shown. Although the two series of aluminum alloy 2017-T4 specimens tested were nominally the same material, there was considerable difference in the fatigue life of the two series of specimens which were acquired at different times. Since the history of the material cannot be traced, no explanation can be given to clarify this inconsistency. Therefore, the test results of these two series of specimens are shown separately in Fig. 1(*b*) and (*c*). The arithmetic mean fatigue life of both materials tested under various conditions is given in Table I. A comparison between the pressurized specimens with the nonpressurized ones is also shown.

For the first series of aluminum alloy 2017-T4 and the carbon steel C1045 tested, there is an indication that the fatigue life is reduced by pressurization, but no similar statement can be made regarding the results of the second series of aluminum alloy tested. No quantitative and statistical studies were made, because it was felt that more experimental data are needed to assure a conclusive analysis.

The reduction in fatigue life of metals after pressurization may be attributed to the possibility that the invisible surface defects of the specimen may have been severed by the fluid under pressure of high intensity. Furthermore, it is not impossible that the residue of the pressure medium on the surface of the specimens may have caused corrosion fatigue to a certain extent. However, a careful examination of the specimens tested revealed no indication of corrosion fatigue.

To seek a possible explanation of the reduction in fatigue life by pressurization, a test was conducted to investigate the change in hardness after exposure to high pressure. A hot-rolled steel bar C1020 $\frac{3}{4}$ in. in diameter and 3 in. long was exposed to hydrostatic pressure of about 100,000 psi for 1 hr. The microhardness of the two polished ends was taken before and after pressurization. Eight readings were taken along a diametral line in each case. A Leitz Durimet microhardness tester was used. Then the pressurized specimen was sectioned at a distance of 1 in. from one end and the microhardness of this section after polishing was measured. It was found that the microhardness in all three cases was about the same except for a hard spot in the material. No distinctive effect of pressurization on the hardness of the steel was observed.

An electron microscopic study of the surface condition before and after pressurization may yield some information which would have bearing on the effect of exposure to high pressure on the fatigue strength of metals.

Acknowledgment:

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Technical Notes

An Extensometer for Testing High-Explosive Materials

The testing of solid high-explosive materials naturally imposes many limitations on the test equipment. In this case, an extensometer of unusual design had to be developed to measure the changes in unit length of a specimen of solid high-explosive substance as it is stressed in tension or compression.

These high-explosive materials provide the energy to assemble fissionable materials in a nuclear weapon at the instant of detonation. They are carefully machined in controlled quantities in special shops. The amount that can be contained under a thumb-nail will take off the whole hand. The physical properties must be known so high-explosive parts that will withstand the various loads and environments can be designed.

The nature of the materials imposed some unusual requirements on the extensometer. It had to (*1*) accommodate a specimen of not more than 1.0-in. gage length and 0.250 in. diameter, (*2*) be easily installed and removed, (*3*) be light enough to impose no significant strain on the specimen, (*4*) be capable of remote read-out, (*5*) be easily calibrated, (*6*) require a minimum of instrumentation, (*7*) be sensitive and accurate enough to provide data for calculating Young's modulus, Poisson's ratio, etc., and (*8*) give reliable, repeatable results.

It was desirable to keep the specimen to small size, simply because of the potential explosive force present. The use of resistance foil strain gages as sensing elements, rather than the conventional differential transformer, was thought most practical. The differential transformer produces a changing electrical signal proportional to the strain in the specimen. The fluctuating magnetic fields produced were believed to be a definite hazard in the presence of somewhat unstable explosives.

Description of Extensometer

A spring steel beam was made of a piece of flat stock 0.750 in. wide, 1.125 in. long and 0.020 in. thick. The center portion of the beam was reduced by grinding to a section of approximately 0.375 by 0.012 in. to concentrate bending stresses in an area covered by the strain gage grid. On the same side, at each end, and at 90 deg to the beam, were soldered brass blocks $\frac{1}{8}$ in. thick, $\frac{1}{2}$ in. wide, and 1 in. long.

Two steel needles were inserted in holes and secured with set screws in

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

each of the brass blocks, the orientation of the two needles in each block being so that the axes of the needles were 90 deg to each other. The needles in each block were so adjusted that their point of intersection (if extended) was at the longitudinal axis of the specimen. The planes of the two needles at either end block are parallel. Two $\frac{3}{16}$ in. diameter by $\frac{3}{4}$ in. long coil tension springs (one at each end block) are used to affix the extensometer to the specimen.

Two Baldwin bakelite-bonded foil strain gages were cemented to opposite sides of the beam over the area of greatest stress concentration. Epon VI cement was used for this purpose. The strain gages were waterproofed with Vyna-Kote liquid vinyl. Leads of Belden indoor aerial wire were soldered to the gages and cemented to one of the end blocks. The gages were connected to adjacent arms of the bridge, thus effecting a double signal output as well as temperature compensation.

Fig. 1.—A standard test bar of $\frac{1}{4}$-in. steel is shown in position in the extensometer. Notice how the strain gage bridges the narrow portion of the spring steel. A similar gage is cemented to the underside.

Calibration of Extensometer

Calibration was accomplished by securing the extensometer to the dummy specimen of a Baldwin portable extensometer comparator. With this comparator it is possible to induce and read extensions to within 0.00001 in. or less. The extensions were measured with both a dial indicator (Starrett, $3\frac{5}{8}$ in. dial, 0.0001 in. graduation) and a set of gage blocks furnished with the comparator. The calibrating range extended from zero deflection to 0.020 in.

The strain signal was read out on a Baldwin SR-4 strain indicator. The extensometer was extended ten times to 0.020 in. increments of 0.004 in. The SR-4 strain indicator indication for each increment was recorded and averaged. The difference of an average of ten readings by gage blocks or dial indicator was less than 1 per cent.

Comparison Tests

Several actual tests were made by attaching the extensometer to test specimens of aluminum alloy 6061-ST, type 304 stainless steel, SAE 1020 steel, and brass, and stressing them in tension to 20,360 psi. Elongation measurements made on a $\frac{1}{4}$-in. diameter 6061-ST specimen loaded to 1000 lb showed an elongation of 0.001992 in. per in. Two Baldwin extensometers (a PS5M and a PS6M) showed an elongation of 0.002000 in. and 0.001975 in., respectively, the PS5M indicating 0.8 per cent higher and the PS6M indicating 0.4 per cent lower than the special extensometer. The accuracy compares favorably with existing commercial extensometers.

Conclusion

This type of strain gage extensometer appears to have many possibilities. It is relatively inexpensive and can be easily made to many different configurations as its application may require. Further development will be undertaken as time permits.

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Lawrence Radiation Laboratory
Livermore, Calif.

Fatigue Damage of Plain Carbon Steels—Effect of Reheating*

The relation between the fatigue damage defined by the Sinclair-Dolan[1] method and French's method[2] has been the subject of recent studies undertaken by T. Yokobori, professor of mechanical engineering, Tohoku University, Japan.

In French's method fatigue damage is measured by the decrease of the original endurance limit. After being stressed beyond the endurance limit, the steel specimens are subjected to ten million cycles of stress at the endurance limit proper. If no failure occurs, the specimens are considered undamaged. Sinclair and Dolan periodically reheated brass to recrystallization to overcome the work-hardening effect of cyclic stress. This process does not significantly influence the finite fatigue life, and thus fatigue damage seems to begin early during the fatigue life. Other metallurgists[3] had previously performed two similar exploratory experiments on SAE X4130 steel. After being overstressed, the one specimen was understressed and retested at the original overstress without failures in 40 million cycles. A second specimen subjected to the same overstress, was normalized in vacuum, reproducing the same temperature cycle of the original stress-relief procedure. Subsequent overstressing of the second specimen revealed the fatigue life to be the same as in the specimens not subjected to reheating. Hence, the conclusion was reached that fatigue damage prior to cracking may be repaired by understressing, not by heat treatment.

Professor Yokobori performed investigations on two series of steel specimens which had been damaged by French's method. After both series had been subjected to overstress, one was stressed immediately to the original endurance limit. The other series was first reheated in vacuum under the temperature cycle of the original stress-relief procedure. The reheated specimens failed during subsequent fatigue tests after less than ten million cycles. The purpose of Yokobori's experiments was to determine whether this damage can be repaired by the reheating process for the removal of work-hardening caused by cyclic stress. The tests were performed on plain, annealed carbon steel specimens with ferrite grain size corresponding to ASTM No. 6.5. Some specimens were provided with a V-notch; all were heated for 1 hr at 650 C for stress relief and cooled in a vacuum furnace. Several specimens

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* A copy of the complete manuscript can be obtained by writing to the author.

[1] G. M. Sinclair and T. J. Dolan, "Use of a Recrystallization Method to Study the Nature of Damage in Fatigue of Metals," *Proceedings*, First National Congress of Applied Mechanics, pp. 647–651 (1952).

[2] H. J. French, "Fatigue and the Hardening of Steels," *Transactions*, Am. Soc. Steel Treating, Vol. 21, pp. 899–946 (1933).

[3] J. A. Bennett, "A Study of the Damaging Effect of Fatigue Stressing on X4130 Steel," *Proceedings*, Am. Soc. Testing Mats., Vol. 46, pp. 693–711 (1946).

were tested to fracture at a stress level above endurance limit on Ono's rotary uniform bending machine. Figure 1 shows the stress amplitude in relation to the number of cycles in a diagram which indicates only small scatter of the fatigue lives.

The st series of specimens were exposed to 500 to 100,000 cycles of stress beyond the endurance limit. Figures 1 and 2 show the results of the subsequent retesting at the original endurance limit during which the specimens failed after less than ten million cycles. This failure supports the conclusion that the fatigue damage established by French's method occurs at an early stage in the fatigue life. The other specimen series was exposed to stress beyond the endurance limit applied in 1000 to 320,000 cycles, then damaged, reheated in a manner similar to the stress relief procedure and retested at the original endurance limit. Figures 1 and 2 show the test results. Comparison of the microstructure of once-heated and twice-heated specimens showed no evidence of decarburization and grain growth. The reheated specimens also failed after less then ten million cycles, exhibiting approximately the same fatigue life as specimens heated only once after machining. The fatigue damage could not be repaired by annealing.

Notched specimens exhibited similar behavior. One series was exposed to various cycles of stress above the endurance limit, then retested at the original endurance limit. The retested specimens failed after less than ten million cycles. The other series was damaged by cyclic stressing, then reheated and cooled. Subsequent testing at the original endurance limit showed again that the fatigue damage had not been restored by annealing. Slight improvements of the fatigue damage, observed in a few notched specimens after understressing, were lost in subsequent reheating for stress relief.

On the basis of the results obtained,

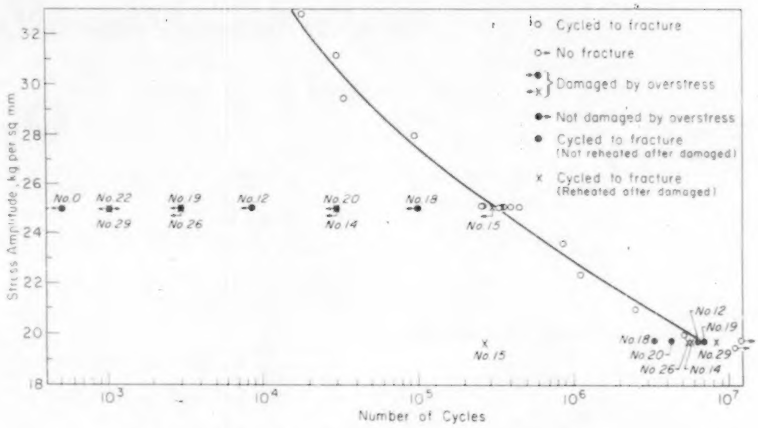


Fig. 1.—Fatigue life of retested, overstressed specimens.

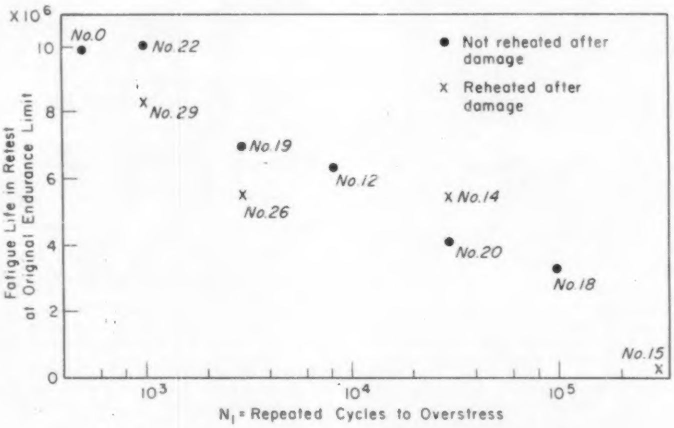


Fig. 2.—Fatigue life of retested, overstressed specimens.

the following conclusions were made concerning the nature of the fatigue damage:

1. The so-called fatigue damage as established by French's method cannot be repaired by subsequent annealing for stress relief even for the early stage of cyclic stressing; however, the damage can be repaired by understressing.

2. The repair by understressing appears to be independent of the sequence in which overstressing and understressing are applied.

3. This repair of fatigue damage by understressing, however, appears to be lost by subsequent annealing for stress relief.

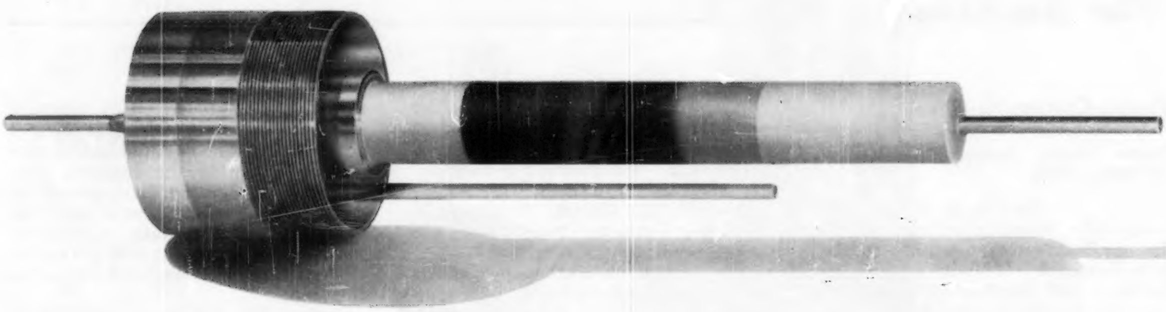
TAKEO YOKOROBI
Department of Mechanical Engineering
Tohoku University
Sendai, Japan

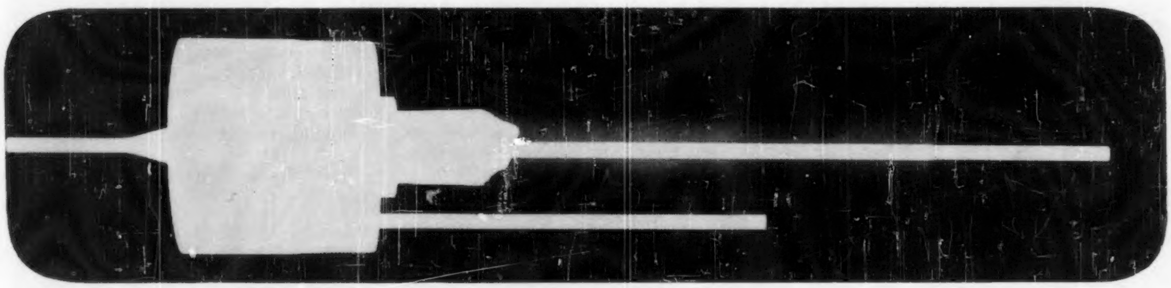
ASTM Bulletin Index—1958

Authors of Technical Papers and Articles

(*R*) denotes 10 or more references.

Subject Index to Papers, Reports, and Articles





The Bookshelf

Electric Contacts Handbook

Ragnar Holm; Springer-Verlag, Berlin, Germany (1958).

THIS book is the third, completely rewritten edition of Dr. Ragnar Holm's well-known *Electric Contacts Handbook*. It is without doubt the foremost and finest book dealing exclusively with the theory and use of electrical contacts. It will prove of unquestionable utility to the electrical engineer, to the scientist, to the application and design engineer, to the student, and to the teacher, regardless of the individual's level of experience and knowledge in the field of electrical contacts. Further, it is written in such a manner that the data given can be clearly understood. Liberal references are made to the literature throughout the book. Such basic information as is needed to supplement the statements given in the book is supported by basic scientific data given in the appendices.

A listing of the main parts into which the book is divided will amply illustrate the scope and depth of the subject matter covered. The five main sections are: (I) Stationary Contracts, (II) Sliding Contacts, (III) Electric Phenomena in Switching Contacts, (IV) History, and (V) Appendices.

The section on stationary contacts will prove equally valuable to the research worker and to the equipment or application engineer. Basic data on contacts, such as formation of films, methods of reducing the deleterious effects of films, contact resistance, temperature rise, corrosion, welding, and the like, are thoroughly covered and well presented. Numerous references to literature and actual test data are given. It would be well for the reader to refer to the appendices for discussion of the basic physics involved to use fully the data presented by Dr. Holm.

Section II gives much basic data on the very important characteristics and theories of sliding contacts. Dr. Holm's extensive background, both practical and theoretical, in this field is well demonstrated. People interested in contacts, whether at the research, academic, or application level, would do well to review this section of the book thoroughly. Basic data on friction phenomena are given so that the reader will more easily comprehend the topics discussed.

Section III will prove particularly useful to the contact application and switch gear people and to contact-development personnel. Data on basic arcing and current flow phenomena, which are needed to understand the operating characteristics of electrical contacts, are adequately covered. Contact transfer phenomena—so important in d-c contact usage—are particularly well treated.

For those wishing to delve into the history of electrical contacts, Section IV will prove valuable and interesting.

(*Continued on page 78*)

The Bookshelf

(Continued from page 76)

It is one of the few places where this subject is treated with any degree of thoroughness.

The appendices given are basic to the full understanding of the data presented in this book. They cover a range of subjects, such as electronic conduction in solids; hardness, strain hardening, and atomic diffusion phenomena; structure, electric and chemical conductivity of carbons; and general theory of the arc that appears in relays.

The information given in any one of these topics is well worth the purchase price of this book. This book should be in every library used by people working with electrical contacts—industry, educational institutions, individuals. It has no equal in its field.

John D. Kleis

Gummi und Kunststoffe

W. Späth, A. W. Gentner, Stuttgart, Germany, 280 pp., 101 figures, 27.50DM (Approximately $6.50), in German.

This book gives a unique presentation of basic concepts of the mechanical characteristics of polymers in relation to testing evaluations and properties of technical importance. The emphasis is entirely on the physical, rather than on the chemical structure, of the materials.

There are three main sections. The first deals with such subjects as internal and external friction and their relationship to ultrasonic vibrations and heat generation; model concepts of polymer structure and their limitations; microscopic and submicroscopic failure processes; and phenomenological realization of elementary processes such as relaxation, creep, and flow. The second section is concerned with technical testing procedures for evaluating the effects of mechanical loading, and contains descriptions and analyses for a wide variety of procedures for tensile testing, hardness testing, and dynamic tests. The subject of residual stresses is given especial attention. The third section contains examples of practical testing procedures chosen to illustrate their connections with the general concepts of mechanical behavior developed in the first two sections. Here are discussed subjects such as the shape of diverse stress-strain curves; effects of temperature on stress-strain curves and other properties; cold stretching; fatigue testing, etc.

The general treatment of the material in the book is new and distinctive. It contains information from many countries which will be widely useful for technological aspects of rubber and plastics. The table of contents constitutes six pages in outline form, while the subject and author indexes together occupy five pages. With these, the topics discussed are easily found.

Prepared for
Rubber Chemistry
S. D. Gehman

Dangerous Properties of Industrial Materials

Edited by N. Irving Sax, Reinhold Publishing Corp., New York, N. Y. (1957), 1467 pp., $22.50.

This completely revised and enlarged edition of *Handbook of Dangerous Materials* provides a welcome safety reference for those involved in the manufacture, use, storage, or shipping of hazardous materials. Some 3500 materials have been added to the 5000 listed in the older book, while still retaining the comprehensive tabulation of the data available, giving for each item: synonyms; description; formula; constants, toxicity; symptoms; treatment; antidotes; first aid; safety precautions; explosion, fire, and diaster control; storage and handling. Interpretation and application of these data are ably promoted by invaluable sections on

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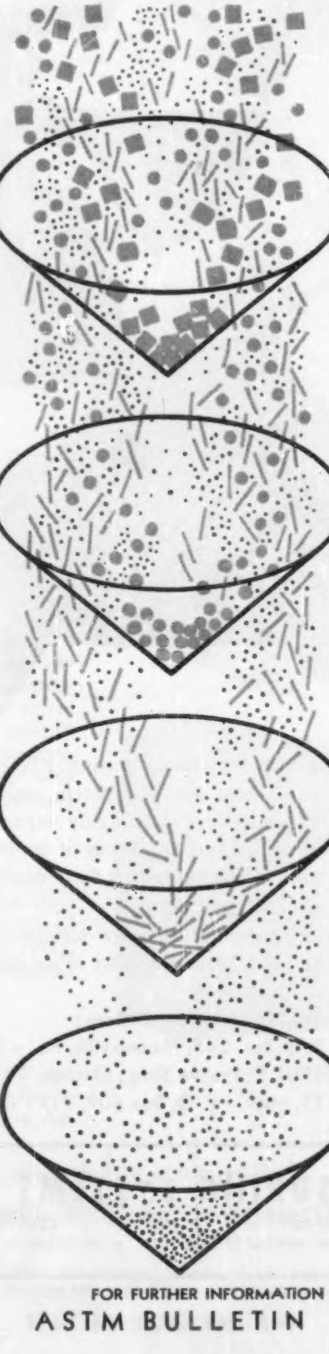

The Bookshelf

(*Continued from page 78*)

toxicology; ventilation control; personnel protection and personal hygiene; atmospheric pollution; radiation hazards; industrial fire protection; storage and handling of hazardous materials; reactor safeguards; allergic disease in industry; shipping regulations; and synonym index. This is undoubtedly the most important single book on industrial safety and should be readily available to technical and nontechnical personnel at all levels in industry.

OTS Research Reports

THESE reports, recently made available to the public, can be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Order by number.

Catalogs of Technical Reports

The CTR's list all reports of research in the respective field available to the public from the OTS collection.

Titanium: Part 1—Titanium and Alloys, 1930–1958. CTR 349, 10 cents.

Titanium: Part 2—Titanium Carbides and Compounds, 1920–1958. CTR 350, 10 cents.

Titanium: Part 3—Barium Titanate, 1946–1958. CTR 351, 10 cents.

Technical Reports

A Pressurized Karl Fischer Apparatus. PB 131501, 50 cents.

Chemical Processes as Methods of Achieving High Temperatures. PB 131549, 75 cents.

A Calorimetric Assembly for the Measurement of Heats of Fusion of Inorganic Compounds. PB 131628, 50 cents.

Bacterial Activity in JP-4 Fuel. PB 131813, 75 cents.

(*Continued on page 99*)

OTHER SOCIETIES' EVENTS

January 5–9—**Highway Research Board,** 38th Annual Meeting, Sheraton-Park Hotel, Washington, D. C.

January 8–9—**The American Society for Engineering Education,** Coop Education Midwinter Meeting, Hotel Del Prado, Chicago, Ill.

January 12–14—**National Symposium on Reliability and Quality Control;** sponsors: Institute of Radio Engineers, American Institute of Electrical Engineers, American Society for Quality Control, Electronics Industries Association; Bellevue-Stratford Hotel, Philadelphia, Pa.

January 12–15—**National Concrete Masonry Assn.,** 39th Annual Convention and 11th Concrete Industries Exposition, Cleveland Public Auditorium, Cleveland, Ohio.

January 12–16—**Society of Automotive Engineers,** Annual Meeting and Engineering Display, Sheraton-Cadillac and Statler, Detroit, Mich.

January 19–20—**Industrial Heating Equipment Assn., Inc.,** Hotel Cleveland, Cleveland, Ohio.

January 19–22—**American Road Builders Assn.,** 57th Annual Convention and 5th Annual Highway Materials and Services Exhibit, Dallas Memorial Auditorium, Dallas, Tex.

January 26–27—**The American Society for Engineering Education,** College-Industry Conference, University of Houston, Houston, Tex.

January 26–29—**Institute of the Aeronautical Sciences,** 27th Annual Meeting, Sheraton-Astor Hotel, New York, N. Y.

January 26–29—**American Society of Heating and Air Conditioning Engineers,** 65th Annual Meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

January 27–30—**Society of Plastics Engineers,** 15th Annual Technical Conference, Commodore Hotel, New York, N. Y.

February 1–6—**American Institute of Electrical Engineers,** Winter Meeting, Statler Hotel, New York, N. Y.

February 3–5—**Society of the Plastics Industry,** 14th SPI Reinforced Plastics Division, Edgewater Beach Hotel, Chicago, Ill.

February 8–13—**American Society of Civil Engineers,** Statler Hotel, Los Angeles, Calif.

February 15–19—**National Sand and Gravel Assn.—National Ready Mixed Concrete Assn.** Conventions, Roosevelt Hotel, New Orleans, La.

February 15–19—**American Institute of Mining, Metallurgical, and Petroleum Engineers,** Annual Meeting, Hotels St. Francis, Sheraton-Palace, and Sir Francis Drake, San Francisco, Calif.

February 19–21—**National Society of Professional Engineers,** Winter Meeting, Dinkler-Tutwiler Hotel, Birmingham, Ala.

February 23–26—**American Concrete Institute,** Annual Meeting, Statler Hilton Hotel, Los Angeles, Calif.

NEW MEMBERS.......

The following 101 members were elected from September 12 to November 12, 1958, making the total membership 9606..... Welcome to ASTM

Note—Names are arranged alphabetically—Company members first then individuals—Your ASTM Year Book shows the areas covered by the respective Districts

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Braswell, James A., chief chemist, Firestone Tire and Rubber Co., Box 1295, Des Moines 5, Iowa.
Craig, F. E., quality control superintendent, Stetson China Co., Lincoln, Ill.
D'Amato, Michael A., vice-president, engineering, Seaman-Andwall Corp., 305 N. Twenty-fifth St., Milwaukee 1, Wis.
Diaz de Cossio, Roger, research associate in civil engineering, University of Illinois, 111 Talbot Laboratory, Urbana, Ill. [A]*
Grand, Irving H., chemist, Technical Dept., Chicago Burlington & Quincy Railroad, C. B. & Q. Tie Plant, Galesburg, Ill. For mail: R. R. D., Gerlaw, Ill. [A]

*[A] denotes Associate Member.

Holmgren, R. Bruce, vice-president and editor, *Package Engineering*, 185 N. Wabash Ave., Chicago 1, Ill.
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Tyler, I. L., manager, Field Research Section, Portland Cement Assn., 5420 Old Orchard Rd., Skokie, Ill.

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Crooks, Ronald O., metallurgist, Associated Spring Corp., Main St., Bristol, Conn. [A]
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Presto, Alphonse R., chemist, Buresh Nonwovens, Inc., Box 424, Westfield, Mass.
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Ruzicka, Jerome E., staff engineer, Barry Controls, Inc., 700 Pleasant St., Watertown 72, Mass. [A]

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Pietrzak, Stanley Joseph, metallurgist, Burgoyne Testing Laboratory, Inc., 542 Main St., Westbury, N. Y. For mail: 401 Roslyn Pl., East Meadow, N. Y. [A]
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Landis, Roy G., laboratory director, Sherwin-Williams Co., Box 4325, Bayshore Station, Oakland 23, Calif.
Maduell, Charles E., president, Anamet Laboratories, Inc., 845 Carleton St., Berkeley 10, Calif.
Tedford, C. W., head, Metallurgical and Chemical Laboratory, Friden, Inc., 2350 Washington Ave., San Leandro, Calif.

(*Continued on page 84*)

New Members

(*Continued from page 82*)

OHIO VALLEY DISTRICT

Foy, William L., technical director, Foy Paint Co., 1776 Menton Ave., Cincinnati 12, Ohio.

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Morgan, David E., director of research and development, Warren Webster and Co., Seventeenth and Federal Sts., Camden 1, N. J.

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Kozlowski, Frank W., laboratory technician, Koppers Co., Inc., Research Dept., Plum St., Verona, Pa. [A]

Prindle, William R., manager of research, Hazel-Atlas Glass Div., Continental Can Co., Inc., Fifteenth and Jacob Sts., Wheeling, W. Va.

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Erwin, Robert G., chief laboratory technician, Law Engineering Testing Co., 136 Forrest Ave. Atlanta, Ga. For mail: 1452 North Ave., N. E., Atlanta 7, Ga.

Frost, Carlton S., president, Gulf Coast Testing Laboratory, Inc., 6500 Forty-ninth St., N. Pinellas Park, Fla. [A]

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Munz, Lee, chief chemist, Kaiser Manufacturing Inc., 2002 Harrington, Houston 26, Tex. [A]

Snedeker, M. H., general manager, Aeronautics, Inc., 207 S. Sylvania, Fort Worth 11, Tex. For mail: Route 1, Box 68, Smithfield, Tex.

Stovall, E. E., superintendent, Gas Measurement Dept., Lone State Gas Co., 301 S. Harwood St., Dallas 1, Tex.

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Miller, William M., Jr., Laboratory and Quality Control, Hedwin Corp., 1600 Roland Heights Ave., Baltimore 11, Md.

Talebzadeh, Marie P., chemist, Englander Co., Inc., 227 N. Warwick Ave., Baltimore 23, Md.

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Dutton, D. B., city engineer, City Hall, Waterloo, Ont., Canada.

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Gem State Testing Laboratory, James A. Burton, chief engineer, 3020 Main St., Boise, Idaho.

Giddings, Ray C., chief engineer, Volcanite, Ltd., Box 1404, Honolulu 7, Oahu, Hawaii.

Gilbert, Gus, treasurer and general manager, State Tile, 158 Sand Island Access Rd., Honolulu 17, Hawaii.

Goff, Vyrl D., manager, Pittsburgh Testing Laboratory, 2419 S. E. Powell Blvd., Portland 2, Ore.

Griffiths, John D., chief engineer, Gate City Steel, Inc., Box 1487, Boise, Idaho.

OTHER THAN U. S. POSSESSIONS

Asbestos Monterrey, S. A., Fernando Abaroa B., engineer, Ave. Industrias 1231 Pte., Monterrey, N. L., Mexico.

Industrias Unidas, S. A., David Roldan G., technical director, Apartado Postal 26783, Mexico 14, D. F., Mexico.

Instituto Brasileiro de Petroleo, Helio Beltrao, president, Caixa Postal 343, Rio de Janeiro, Brazil.

Koninklijke/Shell Plastics Laboratorium Delft, G. J. van der Bie, head, Elastomer Section, Oostsingel 178, Delft, The Netherlands.

Willys Overland do Brasil, S. A., J. E. Hoffernan, supply manager, Caixa Postal 8610, Sao Paulo, Brazil.

Banker, Anil R., partner, Banker Textiles, Adenwala Mansions, Chowpatty Seaface, Bombay 7, India. [A]

Bird, John Richard, chief materials engineer, Igranic Electric Co., Ltd., Elstow Rd., Bedford, England. For mail: 99 Willington Rd., Cople, Bedford, England.

Garcia-Iturbe, Leopoldo, civil engineer, LEMCA, Calle Comerico 50, Coro, Venezuela.

Girard, Guy, engineer, Saguenay Premi, Inc., Blv. St. Jean St. Jean-Evdes, P. Q., Canada. For mail: 250 Gay-Lussac, Arvida, P. Q., Canada.

Granja M., Eduardo, civil engineer, Compania de Construcciones "INCA," Casilla 4211, Guayaquil, Ecuador. For mail: Asuncion 731, Quito, Ecuador.

Lake, G. Quentin, municipal engineer, Burnaby Municipal Hall, 4545 E. Grandview-Douglas Highway, Burnaby 2, B. C., Canada.

Leon, Maxime, civil engineer, 9 Avenue Jose Marti, Port-au-Prince, Haiti.

Levesque, A. R., Technical Dept., Concreters Ready Mix, Ltd., 1450 Laurentian Blvd., Montreal 9, P. Q., Canada. For mail: 2815 Barclay 5, Montreal 26, P. Q., Canada.

Lindstrom, Ingmar, civil engineer, National Confederation of Swedish Civil Engineers, Brunckebergstorg 20 III, Stockholm C, Sweden. For mail: LAMCO, Box 69, Monrovia, Liberia.

Majidzadeh, Kamran, civil engineer, Haarz Engineering Co., Internat., 22 Ave. Farvardin, Tehran, Iran. For mail: Ave. Pahlawi, Yousefabad, K. Bimeh, Tehran, Iran. [A]

Palmer, W. G., chief gas engineer, Canadian Fina Oils, Ltd., Fourth Fl., Bamlett Bldg., Calgary, Alta., Canada.

Poulsen, Ervin, Ellemosevej 109, Hellerup, Copenhagen, Denmark.

Sabin, Guy, chief of technical service, Acieries Electriques d'Ugine, 10, rue du General-Foy, Paris 8°, France.

Villa, Federico, assistant technical manager, Franco Tosi, S. p. A., Legnano, Milan, Italy.

Zara, Gregorio Y., vice-president and dean, Feati Institute of Technology, Sta. Cruz, Manila, Philippines.

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column.

A number of active ASTM members were honored at the 1958 ASM Meeting during the National Metal Congress in October. Succeeding retiring president, George M. Young, is **Clarence H. Lorig,** technical director of Battelle Memorial Institute of Columbus, Ohio. Other ASM officers who have been active in the work of the Society include **Robert H. Aborn,** director of U. S. Steel Corp.'s C. E. Bain Laboratory for Fundamental Research, treasurer. **Dr. A. J. Phillips**, vice-president and director of research, American Smelting and Refining Co., received the 1958 ASM Gold Medal, recognizing his career "as a metal scientist, an inspiring leader, and an able administrator." He is a long time member of ASTM and has served on many technical committees. **Ernest E. Thum,** editor-in-chief of *Metal Progress*, was elected an honorary member of the ASM. For many years he has been active in the Society and its technical committees. **Ray T. Bayless** continues as temporary manager, directing ASM Headquarters activities. A long-time member of ASTM and its Cleveland District Council, Mr. Bayless has served as both chairman and secretary of that council. **Earl R. Parker,** professor of physical metallurgy, University of California, a member of General Research Panel of Joint Committee on Effect of Temperature on Properties of Metals, is a new trustee of ASM.

Wendall D. Anderson, formerly chief engineer, Sanitary Engineering Service, Atlanta, Ga., is now civil engineer, Onconee Clay Products Co., Milledgeville, Ga.

G. A. Baker, vice-president in charge of manufacturing, The Duriron Co., Inc., has retired. He represented the company in ASTM and served on Committee A-10 on Iron Chromium, Iron-Chromium-Nickel, and Related Alloys.

Howard S. Bean, recently retired from the National Bureau of Standards, has been retained as consultant on flow measurement by The Foxboro Co.

James E. Bennett, Jr., is now assistant manager, Concrete Control, Uhl, Hall, & Rich, on the Niagara Power Project. Previously he was with F. C. Torkelson, Engineers.

G. H. Bohn, retired as design and metallurgical engineer, Linde Air Products Co., Aug. 1, 1958. He served on the staff of Linde for many years. Mr. Bohn was an energetic worker on the subcommittees of ASTM Committee B-5 on Copper and Copper Alloys and also contributed several papers.

D. Carl Buck, manager, Stainless Steel Metallurgy, United States Steel Corp., Pittsburgh, Pa., has been named assistant chief metallurgical engineer. He represents his firm on Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys.

R. S. Burns, associate director, Armco Steel Corp., has been advanced to director of metallurgical research. Armco is represented by Mr. Burns on several ASTM committees.

Arnold E. Carden, formerly research engineer, Alcoa Research Laboratories, New Kensington, Pa., is now assistant professor, Department of Engineering Mechanics, University of Alabama, University, Ala.

Frank S. Chaplin, formerly associate director, The Franklin Institute, Phila-

delphia, has opened a consulting engineering practice with offices at Johnson and Plymouth Roads, Plymouth Township, Pa.

Rudolf Czepek, engineer, Voigt & Haeffner A. G., Frankfurt, Germany, is now with CERU-Elektrowarmegesellschaft Czepek and Co., Hausen bei Offenbach/Main, Germany.

Edgar H. Dix, Jr., retired assistant director of research, Aluminum Company of America, recently was awarded the highest U. S. Navy civilian honor. In ceremonies held in the Pentagon, Mr. Dix was presented with the Distinguished Public Service Award for his outstanding contributions to the Navy in the fields of scientific research and development. The Navy citation states, in part: "As assistant director of research of the Alcoa Research Laboratories of Aluminum Company of America, Mr. Dix was the guiding intellect in the development of high-strength, corrosion-resistant aluminum alloys which constitute the basic construction material in modern, high performance naval aircraft. Mr. Dix has devoted a lifetime to aviation in general, and naval aviation, in particular, has benefited greatly from his achievements. His vision, technical competence, and efficient leadership have resulted in outstanding contributions to the nation's defense capability." Mr. Dix is a long-time member of ASTM, representing the Aluminum Company of America on Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys. He was active on other technical committees and also on the Pittsburgh District Council.

M. H. Eastlake, general manager, Wire and Cable Division, Northern Electric Co., Ltd., Montreal, Canada, retired October 31. He represented his company in ASTM for 25 years.

Maynard R. Euverard, until recently technical assistant to vice-president for engineering, American Machine and Foundry Co., New York, N. Y., is now assistant to the president at the company's Union Machinery Division, Richmond, Va., Plant.

W. L. Fink, a national director of the Society, and for many years chief of the metallurgy division, Alcoa Research Laboratories, New Kensington, Pa., was recently promoted to the newly created position of scientific coordinator. This position is equivalent to assistant director. Dr. Fink will stimulate and encourage fundamental research work in ARL and will follow basic work in university and other scientific organizations to obtain maximum benefit for ARL investigations. He is very active in many technical societies, has presented many technical papers, and has been granted numerous patents. One of his outstanding continuing contributions in ASTM involves the Joint Committee on Chemical Analysis by Powder Diffraction Methods. The work of this committee is very extensive and still growing.

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Personals

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John A. Gibbud, formerly director, Engineering Standards and Test Data, Owens-Corning Fiberglas Corp., Textile Products Division, is now a physicist and professional engineer, North Providence, R. I.

Lucius Gilman has accepted a position as manager, Polymer and Plastics Research, Monsanto Chemical Co., Special Projects Dept., Boston, Mass. Previously he was technical staff consultant, Materials Advisory Board, Washington, D. C. He is an active member of ASTM Committee D-20 on Plastics.

Abraham Goldstein, has accepted a position as test engineer, U. S. Naval Air Rocket Test Station, Rockaway, N. J. He formerly was employed as research engineer for Fluor Corp., Ltd., Covina, Calif.

Robert S. Green, executive director of the Engineering Experiment Station at Ohio State University since 1954, and a long-time ASTM member, has assumed new duties as associate dean of the College of Engineering.

J. D. Hanawalt, vice-president, Dow Chemical Co., Midland, Mich. has been assigned to research and magnesium development. Dr. Hanawalt is currently serving on Committee E-4 on Metallography and on the Joint Committee on Chemical Analysis by Powder Diffraction Methods of which he was one of the organizers.

William J. Hart, is now associate professor, Maryland State College, Princess Anne, Md. Previously he was with The Jaunty Fabric Corp., Scranton, Pa.

Victor Hicks has been appointed research professor of physics at Marquette University. He will, however, retain his position as chief physicist at Allen-Bradley Co., Milwaukee, Wis.

Erwin A. V. Horiak, chief engineer, Hercules Motor Corp., Canton, Ohio, was named director of engineering.

Richard E. Jones, has recently retired from Pittsburgh Plate Glass Co. He had represented his company on ASTM Committee C-8 on Refractories.

V. V. Kendall, recently retired as corrosion engineer, National Tube Division, United States Steel Corp. Mr. Kendall, in addition to being an individual member of the Society, represented National Tube Division on Committees D-1 on Paint, Varnish, Lacquer, and Related Products, D-19 on Industrial Water, and A-5 on Corrosion of Iron and Steel.

R. L. Kenyon, former associate director of structural design and administration, was named assistant to the vice-president, research, Armco Steel Corp. He currently represents Armco on ASTM Committee A-1 on Steel.

Raymond A. Kundinger, a long time member of the Society, has retired as technical superintendent of the Dominion Rubber Co., Kitchener, Ont., Canada.

Louis A. McGowan, chief engineer, Pittsburgh Du Bois Division, Rockwell Manufacturing Co., DuBois, Pa., was named assistant chief engineer, Barberton, Ohio, Division.

T. Curtis McKenzie, formerly president, Klem Chemicals, Inc., Dearborn, Mich., is now owner of Solar Testing Service, Fort Lauderdale, Fla.

Carl W. Muhlenbruch, president of Education and Technical Consultants, Inc., has moved his offices to First National Bank Building, Evanston, Ill. He formerly was professor of civil engineering at Northwestern Institute of Technology. Mr. Muhlenbruch is active in the work of the Chicago District.

Howard B. Myers, recently accepted a position as sales manager, Metallurgical Division, Tennessee Products and Chemical Corp., Nashville, Tenn. Formerly he was employed by Pickands, Mather and Co., Detroit, Mich. Mr. Myers is active on ASTM Committees A-3 on Cast Iron and A-9 on Ferro-Alloys.

Robert E. Parkinson, formerly technical assistant to director of research and development, Kawneer Co., Niles, Mich., is now vice-president, Porce-Alume, Inc., Alliance, Ohio. He is currently serving on ASTM Committees C-19 on Structural Sandwich Constructions and C-22 on Porcelain Enamel.

John Sanford Peck, is now adjunct professor of civil engineering, University of Massachusetts, Amherst, Mass. Previously he was professor of civil engineering, The College of the City of New York.

Robert E. Philleo, formerly research engineer, Fire Research Section, Portland Cement Assn., Chicago, Ill., is now employed as civil engineer, Corps of Engineers, Department of the Army, Office of the Chief of Engineers, Washington, D. C. He is an active member of ASTM Committee C-9 on Concrete and Concrete Aggregates.

Maurice M. Platte, is now a member of the technical staff of Hughes Aircraft Co., Culver City, Calif. Prior to accepting his new position, Mr. Platte was materials engineer, Hotpoint Co., Division of General Electric Co., Chicago, Ill.

Lewis S. Reid, retired in September as general purchasing agent, Metropolitan Life Insurance Corp., New York, N. Y. He has been an active member of a num-

ber of ASTM technical committees, having served as both chairman and secretary of Committee D-6 on Paper and Paper Products, and of the Administrative Committee on Standards.

Edward E. Reynolds has been named chief research metallurgist, Alloy Research and Development for Allegheny Ludlum Steel Corp. with offices at the company's Research Center at Brackenridge, Pa. Dr. Reynolds serves on the Joint Committee on Effect of Temperature on the Properties of Metals.

Roy A. Shannon, formerly maintenance officer, Ordnance Corps, U. S. Army Ordnance Depot, Mainz, APO New York, N. Y., is now affiliated with La Crosse System Test Division as project officer, at LaCrosse White Sands Missile Range, N. Mex.

Ernest L. Robinson was recently awarded Honorary Membership in The American Society of Mechanical Engineers "for creative engineering" and for "imagination in conceiving research and investigative programs of the highest order." Mr. Robinson, who is currently serving on the ASME-ASTM Joint Committee on the Effect of Temperature on Properties of Metals, is retired from General Electric Co.

Howard J. Rowe, chief metallurgist, Fabricating Division, Aluminum Company of America, Pittsburgh, Pa., received from The American Foundrymen's Society the McFadden Gold Medal "for outstanding contributions to the Society and to the light metals branch of the castings industry." Mr. Rowe has been active in ASTM since 1941 and is a member of Committees B-7 on Light Metals and Alloys and E-8 on Nomenclature and Definitions.

John E. Rutzler, Jr., assistant professor of physical chemistry, Case Institute of Technology, was joint recipient, with Mr. Dean Taylor, Jr., of the Union Carbide Chemicals Company award, presented at the American Chemical Society meeting in Chicago, Sept. 10, 1958. The award was given in recognition of the paper, "Studies of Adhesion Using Molecular Models."

ASTM Past-President **R. A. Schatzel,** vice-president of engineering and research director of Rome Cable Corp., Rome, N. Y., has been granted a United States patent for Roseal, a polyethylene-butyl rubber resin used primarily as a sheathing compound on electrical wires and cables.

D. O. Schwennesen, works manager, Magnet Metals Co., Camden, N. J., has been elected vice-president. With Magnet Metals since 1956, his new duties will include both engineering and managerial responsibilities.

Howard Scott retired from Westinghouse Research Laboratories, Pittsburgh, Pa., November 1. He represented Westinghouse Electric Corp. on Committee E-4 on Metallography and also served as a consulting member of Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts, and on the Joint Committee on Effect of Temperature on Properties of Metals.

J. R. Shank has resigned as executive secretary of the Department of Industrial Relations, Ohio Board of Building Standards, and has accepted a position with the Ohio State Highway Dept., Bureau of Bridges. Prof. Shank continues as consultant to the Engineering Experiment Station, Ohio State University where he was a professor for 40 years. He is the author of many technical publications.

Victor Siegfried, recently accepted a position as chief engineer, Sequoia Wire and Cable Co., Redwood City, Calif. Prior to that time, he was chief engineer, The Ansonia Wire and Cable Co., Ashton, R. I. Mr. Siegfried is active in many ASTM technical committees.

Ernest L. Spencer, associate professor of civil engineering at Northeastern University and a member of the Medfield Park, Mass., Planning Board, has been named assistant to the university engineer, Charles O. Baird, Jr. He will be responsible for knowledge of the utilities systems at the university, which are as extensive as many small towns, and will study and coordinate the physical needs of the university for future expansion. Active in ASTM for several years, currently he is serving on Committees C-9 on Concrete and Concrete Aggregates and C-1 on Cement.

William E. Sprague is now affiliated with Lockheed Aircraft Corp., Sunnyvale, Calif., as electronic research engineer.

Sidney J. Stein, director of research, International Resistance Co., Philadelphia, Pa., has been appointed director of engineering and research.

Charles E. Thibeau, formerly chief inspector, Insulating Fabricators of New England, Inc., Watertown, Mass., is now president, Conductoflab, Inc., Groton, Mass.

Franz H. Vitovec is now associate professor, metallurgical engineering, Department of Mining and Metallurgy, University of Wisconsin, Madison, Wis. Previously he was associate professor, experimental engineering, University of Minneapolis, Minneapolis, Minn.

V. H. Waite, director of research, McGean Chemical Co., Cleveland, Ohio, has retired. He represented McGean Chemical Co. in its Society membership and on Committee B-8 on Electrodeposited Metallic Coatings for a number of years.

Fred J. Walls, recently retired from the Development and Research Division, The International Nickel Co., Inc., Detroit, is now affiliated with Engineering

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Personals

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Castings, Inc., Marshall, Mich., serving as vice-president. He is a long time member of ASTM and has served on Committee A-3 on Cast Iron, as well as the Detroit District Council.

L. H. Winkler, long-time metallurgical engineer at Bethlehem Steel Co., Bethlehem, Pa., retired from the company effective October 1. A most active member of ASTM for many years, his membership dating since 1913, and a former national director and honorary member, in 1954, will continue his personal affiliation with a number of ASTM technical committees; he represents the Society on certain sectional committees under ASA auspices. Mr. Winkler has given long and faithful service to Committee A-1 on Steel, A-5 on Corrosion of Iron and Steel, B-1 on Wires for Electrical Conductors, and E-1 on Methods of Testing. He has been chairman of many subcommittees which have developed important specifications for steel products. Mr. and Mrs. Winkler will continue to make their their home at 715 Beverly Ave., Bethlehem, Pa.

Ray E. Wright, formerly design engineer, Kett Technical Center, Pompano Beach, Fla., is now affiliated with General Electric Co., Cincinnati, Ohio, as design engineer.

DEATHS...

Charles W. Allen, research engineer, Ohio State Department of Highways, Columbus, Ohio, died October 10, 1958. He had been a prominent member of Committees C-15 on Manufactured Masonry Units, D-4 on Road and Paving Materials, D-1 on Paint, Varnish, Lacquer and Related Products, D-18 on Soils for Engineering Purposes, C-9 on Concrete and Concrete Aggregates, and C-4 on Clay Pipe. In addition, he was a past officer of Committee D-4, acting as chairman of several subcommittees.

Victor A. Crosby, manager, Automotive Development, Climax Molybdenum Co., Detroit, Mich., died October 2, 1958. Aside from being an ASTM member since 1934, Mr. Crosby was active in Committees A-3 on Cast Iron and A-7 on Malleable-Iron Castings.

Wesley W. Horner, partner, Horner & Shifrin, Consulting Engineers, St. Louis, Mo., died September 22, 1958. Mr. Horner was a member of the Society for 22 years and had served on Committee C-13 on Concrete Pipe.

Frank P. Gilligan, secretary-treasurer, The Henry Souther Engineering Co., Hartford, Conn., died September 5, 1958. He represented the company membership in the Society for a number of years and also served on several technical committees. Mr. I. Laird Newell, president, will succeed Mr. Gilligan as the company representative.

William T. Long, highway engineer, Maryland State Roads Commission, Baltimore, Md., died recently. Mr. Long served on numerous subcommittees of Committee D-1 on Paint, Varnish, Lacquer and Related Products.

James T. MacKenzie, retired chemist and metallurgist, American Cast Iron Pipe Co., and recently consultant, Southern Research Institute, Birmingham, Ala., died suddenly November 18, 1958. Affiliated with ASTM since 1918, Mr. MacKenzie, a member in perpetuity, had rendered valued service to the Society, serving on the Board of Directors, the Southeast District Council, and a number of the technical committees. From 1944 till 1948, Mr. MacKenzie served as chairman of Committee A3 on Cast Iron. He was elected to Honorary Membership in ASTM in 1956. His technical papers brought him wide recognition in foreign countries, as well as the United States.

Donald E. Sharp, assistant director of research, Libbey-Owens-Ford Glass Co., Toledo, Ohio, died a short time ago. He was a member of ASTM for a number of years and served on Committee C-14 on Glass and Glass Products.

NEWS NOTES ON
Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The Society is not responsible for statements advanced in this publication.

LABORATORY ITEMS

Voltage Stabilizers—A redesigned line of constant voltage stabilizers incorporates automatic overload or short circuit protection when load current is increased in excess of normal operating load.
Acme Electric Corp. 1745

Circuit Tester—Model 101-SAF, the latest model of a line of Igniter Circuit Testers, is a more rugged version of preceding models.
Allegany Instrument Co., Inc. 1746

X-Ray Quantometer—New direct-reading X-ray fluorescence instrument for analysis of all elements above atomic No. 11 has been announced. Simultaneous analysis of up to 22 elements in the wavelength range 0.35 to 10.2 Å. is provided from a single sample.
Applied Research Laboratories, Inc. 1747

Furnace—A new gradient furnace, new model thermocouple calibrator, and a complete line of retorts are available.
Arcweld Manufacturing Co. 1748

Transistor Timer—Transistorized time-delay relay for intervals from 50 millisec. to 4.0 min. for operation from external power supply of 40 to 60 v dc.
Automatic Timing and Controls, Inc. 1749

Pendulum Test—A newly developed torsion pendulum for materials testing designed primarily for determining the crystallinity of articles fabricated from "Teflon" resins has been announced. The unit was developed in conjunction with the Du Pont Co. and is the first commercial instrument of its kind available for this purpose.
Baldwin-Lima-Hamilton Corp. 1750

Ultracentrifuge—With the development of new auxiliary equipment, the Beckman/Spinco Model E Ultracentrifuge is available in a new model designated the Model E-HT which permits the separation, identification, and characterization of materials at temperatures as high as 120 or as low as 0 C.
Beckman Instruments, Inc., Spinco Division 1751

Ion-Exchange—Suitable for the performance of chromatographic fractionations of high-molecular-weight materials beyond the range of conventional resins, a new series of four analytical-grade ion-exchange materials based on cellulose is being offered.
Bio-Rad Laboratories 1752

Potentiometer Tester—A new Potentiometer Linearity Tester, Model LT-2 is designed for use as a production inspection gage to determine whether individual potentiometers meet a predetermined linearity tolerance.
Boller & Chivens, Inc. 1753

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Laboratory Items

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Thickness Gage—Gammascan, an entirely new noncontacting gage has been put on the market. The machine continuously measures the thickness and density of materials through the use of gamma radiation.
The Budd Co., Nuclear Systems Div. **1754**

Universal Testing Machine—A new 400,000 lb Universal Testing Machine, Model UEH, has been announced. The machine can exert up to 400,000 lb tension or compression on metal specimens, parts, or structures.
The Budd Co., Tatnall Measuring Systems **1755**

Fading Tester—Xenotest light fading and weathering tester is said to be the sole one used in international standardization tests.
G. F. Bush Associates **1756**

Strain Indicator—A new, portable, direct reading strain indicator, the Model DR-10 provides continuous indication of static and dynamic strain with a minimum of operator adjustment. Strain is indicated directly on a wide scale meter eliminating the necessity to balance the instrument.
Bytrex Corp. **1757**

Magnetic Tape—A new, completely integrated electronic test set comprised of a group of high-quality basic test instruments is now available. Known as the Data Tape Type 23-203 Test Set, the new unit is designed to carry out fast, accurate adjustments and measurements on CEC's 5-752 Magnetic-Tape Recorder/Reproducer.
Consolidated Electrodynamics Corp. **1758**

Alumina-Silicate Glass—Cathode ray bulbs made of optical quality high-temperature alumina-silicate glass are now available. The glass withstands tube processing and operating temperatures up to 700 C. It is ideally suited for applications where, as in cathode ray tubes, extremely high temperatures are required in screen-baking transparent phosphors to the faceplate.
Corning Glass Works **1759**

Microfinish Comparator—New Lightweight pocket model Microfinish Visual Comparator, molded of impact styrene plastic, has been announced. It provides a ready precision reference for the accurate inspection of machined surfaces.
Double T Products Co. **1760**

Scale—A new double ratio bench counting scale, Model 105C, with ratios of 1:10 and 1:50 has been introduced. This new counting scale incorporates all the features of the Homs scale line including full capacity beam and all-steel construction.
Douglas Homs Co. **1761**

Galvanometer—A new galvanometer with built-in 6-position shunt provides instant varying sensitivity with critical damping. Dual, curved 150 mm scale is subdivided 0–150 and 75–0–75, permits both deflection and null measurement.
Ealing Corp. **1762**

Profile Measure—A new instrument that uses two beams of light to solve the difficult problem of inspection of turbine engine blading is available. Known as the Kodak Section-Profile Projector, the instrument is based on a new engineering approach. The new design permits viewing of an entire section of a compressor blade, vane, turbine bucket, or half of a forging die.
Eastman Kodak Co. **1763**

Chart—For the engineer who must make calculations to the sixth decimal point, a new pocket-size conversion chart has been prepared. The chart is printed in black and red on a white plastic card and shows at a glance the conversion of small angles (from one second to one minute) to micro-inches per inch, per 10 inches, and per foot.
Engis Equipment Co. **1764**

Test Chamber—A new 27 cu ft altitude, humidity, temperature test chamber, interior dimensions of 3 by 3 by 3 ft is being offered. Standard test range is −100 to +200 F, 20 to 95 per cent RH and 100,000 ft altitude. Greater test ranges, cabinet sizes, and accessories are available.
Environmental Equipment Co. **1765**

Spectrofluorometer—Two new types of Spectrofluorometer are now available. One is a dual-purpose instrument for spectrofluorometric transmission measurements in the spectral region from 220 to 650 mμ. The second is a triple-purpose instrument which can be utilized as a spectrofluorometer, spectrophotometer, or for reflect-

ance measurements of solid samples such as textiles, plastics, paints, paper, powders, etc.
Farrand Optical Co., Inc. 1766

Shear Tester—The new shear tester measures yield stress, which may then be used to determine new correlation parameters which promise to play the same role in stock hydraulics as the Reynolds number plays in true fluid flow work.
Fischer & Porter Co. 1767

Dielectric Measurements—Dielectric constant and dissipation factor of low-loss solid insulating materials can be measured directly and easily in the 200–5000 Mc frequency range with the Type 874-LM Dielectric Measuring Line.
General Radio Co. 1768

Data Loggers—A new line of "off-the-shelf" data logging equipment has just been announced. Two models are available—Model 166 has a 48 point scanning system with a single range typewriter readout, and Model 167 includes the necessary additional circuitry for multi-range selection.
Gilmore Industries, Inc. 1769

Ultra-Microtome—Differs in many ways from the microtomes known today. Its design renders unnecessary the incorporation of precision-made parts in the feed and motion mechanics, and so guarantees the freedom from backlash indispensable for the production of ultra-thin serial sections.
William J. Hacker and Co., Inc. 1770

Microscopic Photography—One single adapter ring attached to the lensboard of the SINAR convertible viewcamera adapts it to any microscope for photomicrography The microscopic adapter with an inside diameter of 25 mm, fits over the eye-piece tube of any standard microscope. It can be made to order for other microscopes.
Karl Heitz, Inc. 1771

Thread Cutting—A new semiautomatic thread generating machine which cuts accurate external and internal threads is now available. Called the JAGGI MF-57, the new machine provides a number of time and cost saving advantages for the precision instrument industry.
Carl Hirschmann Co., Inc. 1772

Brush Spring Testing—A standard force measuring gage mounted in an easy-to-operate test fixture has simplified and standardized functional testing of brush springs. The gage is used to check the load developed by constant-force brush springs at both initial and final lengths.
Hunter Spring Co. 1773

Furnace—A new design, electrically heated, high-temperature furnace for operation up to 3100 F without the requirement of a protective furnace atmosphere has been announced. Known as KR-SUPER, this design is the latest addition to the line of electric furnaces for the metallurgical, ceramic, and chemical industries for laboratory and production processing.
K. H. Huppert Co. 1774

Instrument Protector—A new device offering positive protection for such instruments as incline manometers, draft gages, electrical pressure switches, and ultra-sensitive low-pressure transducers has been announced.
Industrial Engineering Corp. 1775

Power Oscillator—This instrument supplies 160 v amp of power at either a fixed frequency of 400 CPS ± 25 per cent or a variable frequency with a range of 350–450 cps. An input jack is also provided for output frequencies from 50 to 4000 cps.
Industrial Test Equipment Co. 1776

Laboratory Safety Device—A new laboratory safety device allows water-cooled chemical apparatus or physical apparatus to be left unattended with safety. The instrument, actuated by a diaphragm type level switch, is complete with a series of outlets and pilot lights.
Instruments for Research and Industry 1777

Vibration Machine—To meet increasing demands for vibration machines with larger motions the BVA-25 Mechanical Vibration Machine provides double amplitudes up to 1 in. maximum.
L. A. B. Corp. 1778

Automatic Titrator—An automatic titrator, whose speed and accuracy have won it high reputation in its original design, is now diversified for industrial research and routine processing.
Laboratory Glass and Instruments Co. 1779

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Laboratory Items

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pH Electrodes—A new miniature pH electrode assembly is offered for use with samples ranging in size from one drop up. The two electrodes, reference and measuring, can be inserted in an opening of 7 mm diam. and a flexible electrode support then permits the user to squeeze the two elements together and thus accommodate the single-drop sample, as for instance in the tip of a centrifuge tube.
Leeds & Northrup Co. 1780

Optical Instrument—The "Omniscope," a new optical instrument with a 180 F hemispheric field of view, is announced. Built as a periscope or borescope, it transmits this extremely wide angle field of view from inaccessible, hazardous, or remote regions.
Lerma Engineering Corp. 1781

Tube Furnaces—Improved and redesigned combustion tube furnaces which will meet the requirements of all combustion tube methods of carbon and sulfur analysis on ferrous, non-ferrous, and petroleum samples have been announced. Provides low cost operation at continuous temperatures up to 2650 F.
Lindberg Engineering Co. 1782

Oscillograph—A new method of blocking off unwanted individual traces of an automatic multi-channel oscillograph consists of a block holding several easily-adjusted blades which can be lowered to shut off the beam of light from any one of the several galvanometers operating in the oscillograph.
L-W Photo Products 1783

Time-Time Plotter—Model 750–1 Time-Time Plotter will record the duration and time of each event in a series of events occurring at regularly or irregularly spaced intervals over a period of time.
Mast Development Co., Inc. 1784

Standard Bridge—A megohm bridge which meets the need for calibration of high megohm resistors to close tolerance has been announced. This laboratory standard covers the range from 1000 ohms to 1.1×10^{14} ohms. It is completely battery operated, and is furnished in a hand rubbed solid oak case.
Mid-Eastern Electronics, Inc. 1785

Micro Switch—A new ultra-small quick-connect switch with the highest electrical rating of any similar tiny switch has been introduced. Underwriters' Laboratories listing for the new switch is 10 amp, 125 or 250 v ac; $\frac{1}{2}$ amp, 125 v dc; $\frac{1}{4}$ amp, 250 v dc.
Minneapolis-Honeywell Regulator Co. 1786

Servo Millivoltmeter—A new line of miniature high performance self balancing servo indicators for providing remote visual and electrical read-out for temperatures, pressures, position, strain, etc., has been announced.
North Atlantic Industries, Inc. 1787

Surface Density Tester—Two new probes, Models P21 and P22 Surface Moisture and Surface Density Probes, permit rapid determination of moisture content and density on the surface level.
Nuclear-Chicago Corp. 1788

Radioactive Standards—First commercial availability of eight longer-lived radioactive isotope standards, previously supplied by the National Bureau of Standards, has been announced.
Nuclear-Chicago Corp. 1789

Soil Compression—A new, manually operated machine for unconfined compression testing of soil samples has been announced. Weighing 12 lb and measuring 6 by 8 by 20 in., the Model 545 has a capacity of 500 lb. It will handle samples up to 3 in. diam by 8 in. high.
Tinius Olsen Testing Machine Co. 1790

Digital Clock—A new, easily set, universal, digital clock, Model 281, in which both visual indication and all 3 independent decimal outputs are resolved to one second has been announced.
Panellit, Inc. 1791

Temperature Controller—A pneumatic recording temperature control for industrial applications is announced. The control is designed to utilize a 15-lb air line to actuate an air-operated steam valve or other air-operated devices.
Partlow Corp. 1792

D-c Power Supply—Development of a wide voltage range d-c Power Supply with

magnetic amplifier regulation has been announced. The designated Model No. M-1193 provides a d-c output of 5–50 at 50 amp from an a-c input of 110, 220, or 440 v 60 cps, single phase.
Perkin Engineering Corp. 1793

D-c Test Set—Designed for remote control of a compact 50 kv d-c high-voltage oil-tank section, the control unit utilizes a new sloping front cabinet with a removable instrument panel which is set back to protect the components.
Peschel Electronics, Inc. 1794

Magnetic Inspection—A completely new and advanced line of magnetic particle inspection equipment and supplies with many outstanding features are offered.
Peterson Machine Tool, Inc. 1795

Isotope Machine—A 58-lb portable isotope machine that packs into a case the size of an overnight bag and permits one-man radiographic inspection of industrial equipment has been announced.
Picker X-Ray Corp. 1796

Fineness Gages—A new 4-edge double-life scraper for Fineness Grind Gages is available in hi-grade steel or hard chrome plate coat at only a slight increase in price over the conventional scrapers.
Precision Gage and Tool Co. 1797

Sulfur Apparatus—This new, expandable, unitized apparatus is for the determination of sulfur in petroleum products according to ASTM Method D 1266. The basic control unit has all of the necessary controls, as well as the glassware and other equipment, to run four samples simultaneously.
Precision Scientific Co. 1798

Ratio Computer—The Ratio Computer, a scintillation detector of 4 pi geometry, has maximum counting efficiency. Combined with either a single or multi-channel analyzer, the computer determines the energy level of radiation; identifies the radioactive isotope, and measures the amount.
Radiation Counter Laboratories, Inc. 1799

Microwave Target—The MTG 100X is an X-band microwave radar test set capable of providing a delayed target to a pulse radar at its microwave frequency. The target pulse is locked to the radar frequency by means of an AFC loop.
Remanco, Inc. 1800

Hot Plate—A new combination hot plate and magnetic stirrer for laboratory use has been developed. This hot plate produces the required heat at the plate surface but is so designed that the stainless steel case remains cool at all times for safe handling.
E. H. Sargent and Co. 1801

Recorder—Faster square cornering recorder response with a unique tolerance for widely varying input resistance is now accomplished in the precision potentiometric recorder. Standard full scale balancing speed is now one second.
E. H. Sargent and Co. 1802

Extension Tester—Model CRE Tensile Elongation Tester, a constant-rate-of-extension tester of highest attainable precision at moderate cost has been announced.
Scott Testers, Inc. 1803

Magnet—The Automagnet is a compact, sealed arrangement of the most powerful permanent magnet, requiring a simple plunger manipulation to extract magnetic material from one container and automatically discharge it to another.
Sepor Laboratory Supply 1804

Road Tester—An inch by inch profile of the surface of a road, airstrip, or pavement area is now available in permanently recorded form, with the announcement of the availability of the Model CT-444 Road Roughness Indicator.
Soiltest, Inc. 1805

Brinell Hardness Tester—For high-production Brinell hardness testing where location of the test must be accurate, a machine that determines the workpiece position before it can operate has been developed. A precision limit switch located in the table fixture must be depressed by the part before the knee-actuated cycle-switch becomes energized.
Steel City Testing Machines, Inc. 1806

Analyzer—The Technicon Auto Analyzer, a new system for continuous automatic chemical analysis, that can detect

(Continued on page 98)

Laboratory Items

(*Continued from page 97*)

trace materials down to parts per billion, with an accuracy of 1 per cent is announced.
Technicon Controls, Inc. 1807

Solenoid—A new high-speed solenoid which completes its stroke in less than 20 millisec has been announced. The compact RS 5174 solenoid is designed to operate with a 24-lb load.
Telecomputing Corp. Telco Sales Div. 1808

Instrument Housing—New fiber glass reinforced instrument housings which are light, strong, and corrosion-proof have been introduced. The new housings are ideal for use in the chemical and allied industries where corrosion is a problem.
Warminster Fiberglass Co. 1809

Vibration Tester—A new instrument with wide electronic, industrial, and aircraft applications offering a new method of measuring distance and vibration has been announced. This latest development may be used for vibration tests to meet JAN-MIL specifications in electronic components and to measure vibration in rotating shafts or bearings.
Wayne Kerr Corp. 1810

Multipoint Recorder—A new multipoint recording potentiometer, capable of handling from two to twenty-four points by means of simple plug-in adapter units has been designed and produced. Known as Mode 6702, the instrument is designed to measure any number of variables by means of a simple and inexpensive kit of change-over-parts.
Weston Instruments Division of Daystrom, Inc. 1811

CATALOGS & LITERATURE

Thermocouples—A new and enlarged data catalog describing AerOpak Thermocouples for users in the nuclear, aircraft, industrial, and process fields has been announced. The catalog is generously illustrated with data, charts, and pictures. It specifies a choice of diameters, materials, typical connectors, junctions, and termination.
Aero Research Instrument Co. 2484

Infrared Filters—Progress Report No. 3 entitled "Near-Infrared Transmission Filters" is now available. The report summarizes the technical data which have been compiled on the selective transmission of energy through multilayer interference filters.
Bausch & Lomb Optical Co. 2485

Ultracentrifuge—New 12-page brochure *SBL-2*, gives full up-to-date information on the widely used Model L Preparative Ultracentrifuge. Notes are included on applications, field services available, features, and operating characteristics of the standard unit.
Beckman Instruments, Inc., Spinco Div. 2486

Infrared—A new data sheet, "Microsampling Techniques Make Infrared Spectroscopy a Versatile Analytical Tool for the Chemist," is now available.
Beckman/Scientific and Process Instrument Div. 2487

Silent Sound—A new house organ devoted to industrial techniques and applications of inaudible sound is now available. Drawing on twelve years of experience in the use of high frequency sound for gaging, cleaning, and testing, Branson is issuing the "News" to exchange information on the latest developments in the field.
Branson Ultrasonic Corp. 2488

Thermometer Catalog—*Catalog 586* contains specifications and prices of over 1000 thermometers and hydrometers, including thermometers for general use from −200 to 1050 C, complete ASTM list, precision, ground joint, industrial, and dial types, and describes the unique Permanent (P-M) Markings which never wear off.
Brooklyn Thermometer Co. 2489

Amplifier—*Bulletin A1 132.1* describes in detail CEA's new high current, high voltage wideband d-c amplifier. The new amplifier is designed for applications requiring a differential, isolated, or grounded amplifier and is available in six amplifier modules or as single packaged units.
Computer Engineering Associates, Inc. 2490

Testing Catalog—*Catalog No. 59* contains illustrations and brief descriptions of 60 different testers or equipment manufactured as standard products. The testers and equipment are used in adhesives, cement, calibration, insulation, metals, paper, plastic, rubber, textiles, and fats-wax.
Custom Scientific Instruments, Inc. 2491

Thermometer—A new, profusely illustrated eight-page booklet, *Bulletin 13E*, describing a complete line of stainless steel thermometers has been issued.
W. C. Dillon and Co., Inc. 2492

Catalog—A new 24-page catalog of Pye Scientific Instruments describes products such as Pye amplifiers and voltmeters, fluxmeters, galvanometers, Kelvin and other type bridges.
The Ealing Corp. 2493

Catalog—A new catalog presents in a 12-page ready-reference format photographs and digest descriptions of the modern gages and inspection devices required in this era of electronics, nucleonics, missiles and rockets, miniaturization, and automation.
Engis Equipment Co. 2494

Instruments Brochure—Publication of a scientific brochure on the subject of Glennite instruments and instrumentation systems is announced. Entitled, "Measurements and Controls" it is a four-page, two-color, illustrated brochure.
Gulton Industries, Inc. 2495

Laboratory Catalog—The availability of a new, 175-page catalog illustrating and describing more than 450 different pieces of instruments and apparatus is announced.
Labline, Inc. 2496

Chemical Analysis—Twenty-one new application sheets outline the solution to various chemical analysis problems through the use of Leco laboratory apparatus. The subjects covered include the determination of ash in paper; sulfur in limestone; sulfur in oil, soil, plant tissue, alumina ore, clay; carbon in clay; carbon in glass and sulfur in glass.
Laboratory Equipment Corp. 2497

Furnace—A new sheet describing briefly various heating, treating, processing, production, and laboratory furnaces and two series of forced convection ovens for laboratory and production use is available.
L & L Manufacturing Co. 2498

Magnetic Amplifier—A four-page color brochure, S-893, describes a new line of Transi-Mag Servo Amplifiers with power ratings to 16 w.
Magnetic Amplifiers, Inc. 2499

Testing Machine—A 4-page, colored pamphlet describes new testing machine designed for elevated temperature testing.
Marquardt Aircraft Co. 2500

Low Voltage—Low d-c potentials in the microvolt ranges can now be read easily by means of a new precision chopper inverter. The manufacturer offers a free 9-page brochure "Low Level D-C Measurements," detailing instrumentation and circuit design applications.
Microdyne 2501

Gas Thermatron—A newly improved process control instrument for continuous measurement of the concentration of one gas in multi-component mixtures is described in *Bulletin No. 0716-2.*
Mine Safety Appliances Co. 2502

Weighing System—A 4-page, two-color bulletin, 169, describing a new calibrating and weighing system is now available.
Morehouse Machine Co. 2593

Electron Optics—A new 16-page booklet containing engineering data on electron optical instruments is available.
Philips Electronics, Inc. 2504

Vacuum Pumps—A two-page bulletin, No. 604, announces a new, two-stage, mechanical, vacuum pump of 75 liters per min free air capacity with an ultimate vacuum of 0.1 μ or better.
Precision Scientific Co. 2505

Temperature Sensing—A new bulletin, describing the advantages of diaphragm temperature sensors for use in appliances, is now available.
Robertshaw-Fulton Controls Co. 2506

Testing Programs—Engineering testing programs for soils explorations, soils studies, and quality control of concrete and asphalt can be carried out with a line of mobile testing laboratories described in a new brochure.
Soiltest, Inc. 2507

Variable Pulser—A new two-page technical bulletin describing the operation of the Model 1010 Variable Pulser, an instrument for converting any type signal source with a repetition rate up to 5 Mc into standardized pulses of controlled amplitude and duration has been published.
Technitrol Engineering Co. 2508

Bourdon Gauges—A new type of accurate pressure sensitive instrument that makes possible high precision pressure reading up to 500 psi is now available.
Wallace & Tiernan, Inc. 2509

Catalog—Illustrated and indexed is a 16-page catalog, No. P58, in plastic laboratory ware. There are 78 different types of apparatus from beakers to vacuum drums, all carefully selected for their "laboratory fitness."
Will Corporation 2510

INSTRUMENT COMPANY NEWS

Carlson Co., Oceanside, L. I., N. Y.—The Carlson Co. has purchased the entire Reichester Elasticometer Spring Tester inventory from Testing Equipment Co.

E. H. Sargent and Co., Chicago, Ill.—The election of Paul H. Sherrick as vice-president of E. H. Sargent and Co. has

been announced by T. M. Mints, president. Mr. Sherrick has been with the company since 1931 and is in charge of Sargent's research and development laboratories, and glass and instrument manufacturing divisions.

Ultrasonic Testing and Research Laboratory, Van Nuys, Calif.—R. E. Kleint, formerly of North American Aviation, Inc., has been appointed vice-president and general manager of Ultrasonic Testing and Research Laboratory.

NEWS OF LABORATORIES

American Wash and Wear Institute, Ashville, N. C.—A well-equipped laboratory has been set up to assist in evaluating wash and wear fabrics or garments. A photographic rating method is used to show the results precisely. A numerical value of per cent wash and wear effectiveness is assigned to each photograph. George Fine is executive secretary.

OTS Reports

(Continued from page 80)

Measurements of the Viscosity of Gas Mixtures. PB 131573, 75 cents.

High Temperature Solid Dry Film Lubricants. PB 131986, 75 cents.

Effect of Metals on Lubricants: Part 1—Design, Development, and Instrumentation of a High Temperature Bath. PB 131505, 50 cents.

Effect of Metals on Lubricants: Part 2—Corrosion and Oxidation Stability at 400° Fahrenheit. PB 131710, $1.

Determination of Leakage Values of Seals. PB 111545, $4.

Evaluation of High-Temperature Hydraulic Seals to Temperature of 550 F: Part 1—Mechanical Evaluation. PB 131762, $3.

Design Data for O-Rings and Similar Elastic Seals: Part 3. PB 131802, $2.25.

Laboratory Evaluation of Silane Fluids as Potential Base Stocks for Hydraulic Fluids and Lubricants. PB 131889, $1.

Research on the Flammability Characteristics of Aircraft Hydraulic Fluids. PB 131938, $1.

A New Thermal Conductivity Leak Detector and Its Applications. PB 131774, 50 cents.

250 C Ceramic Capacitor with Wide Temperature Range. PB 131893, $3.

Research and Development on Ultra-Thermic 500 C Capacitors. PB 131848, $2.25.

Research on Aluminum Antimonide for Semiconductor Devices. PB 131849, $1.

High-Temperature Insulation for Wire. PB 131812, $1.

High-Temperature Electrical Insulating Inorganic Coatings on Wire. PB 131811, $2.

Study, Standardization of Specifications for Insulated Cable. PB 131805, $3.50.

Pressure Induced Metallic Transitions in Insulators. UCRL-5210, 50 cents.

Nonmetallic Ferromagnetic Materials: Part 6—Ferrite Measurements Program. PB 131039, $2.75.

A Study of the Possibility of Reinforcing High-Temperature Alloys by Addition of Refractory Powders. PB 131768, $1.25.

Development and Evaluation of Insulating-Type Ceramic Coatings: Part 1—Development and Small-Scale Testing. PB 131752, $2.50.

A Study of Graded Cermet Components for High-Temperature Turbine Applications. PB 131434, $1.25.

Nondestructive Readout of Multilevel Magnetic Memory. PB 131475, 75 cents.

Electron Tubes for Critical Environments. PB 131852, $3.50.

Properties and Handling Practices for Magnesium: A Literature Survey. ANL-5749, $2.75.

Test Methods for Magnesium Surface Treatments. PB 131600, $1.75.

A Basic Study of Corrosion of Magnesium. PB 131662, $1.50.

Electrochemical Mechanisms of Noble-Metal/Hydrogen Systems: Part 1—Platinum PB 131526, $1.

Determination of the Mechanical Properties of a High Purity Lead and a 0.058 Copper-Lead Alloy. PB. 131818, $1.25.

Studies and Comparison of the Properties of High Temperature Alloys Melted and Precision Cast Both in Air and in Vacuum. PB 131807, $2.50.

Effect of Prior Creep on Mechanical Properties of Aircraft Structural Metals: Part 2—17-7PH Alloy (TH 1050 Condition). PB 131826, $2.50.

A Summary of Compressive-Creep Characteristics of Metal Columns at Elevated Temperatures. PB 131825, $1.75.

The Effect of Atmosphere on Creep-Rupture Properties of a Nickel-Chromium-Aluminum Alloy. PB 131735, 50 cents.

(Continued on page 103)

Federal Government Standards Changes

THE Federal Supply Service of the General Services Administration is charged with the responsibility for establishing specifications to be used by the Federal Government for procurement of materials and supplies. The GSA issues an annual Index of Federal Specifications, Standards, and Handbooks, and monthly supplements.

The items listed below appeared in Supplements Nos. 6 and 7 for the months of August and September, 1958.

INITIATIONS

Title	Type of Action	Symbol or Number	FSC Code	FSSC Class	Assigned Agency & Preparing Activity
Acoustical Units; Prefabricated	Int. Am. 2	SS-A-1118b	..	..	GSA-FSS
Amyl Acetate (for use in Organic Coatings)	Rev.	TT-A-511b	6810P	..	GSA-FSS
Barrels; Wood, Slack	Am. 3	PPP-B-41	8110	..	DOD-Army-QMC
Board; Tag, Jute	Rev.	UU-B-00611b (GSA-FSS)	9310	..	GSA-FSS
Board; Tag, Manila	Rev.	UU-B-00613b (GSA-FSS)	9310	..	GSA-FSS
Cleaning and Preparation of Ferrous and Zinc Coated Surfaces for Organic Protective Coating	New	TT-C-490	8010	..	DOD-Army-Ord.
Cloth, Jute (or Kenaf), Burlap	Am. 1	CCC-C-467	8305	83	GSA-FSS
Cloth, Pyroxylin, Coated	Rev.	CCC-C-501a	8305	83	DOD-Army-QMC
Conduit, Steel, Rigid, Zinc-Coated	Am. 2	WW-C-581a	5975	17	GSA-FSS
Copper-Silicon Alloy: Bars, Plates, Rods, Shapes, Sheets, and Strip	Rev.	QQ-C-591a	..	..	DOD-Army-Ord.
Crates, Wood, Household Goods	Am.	PPP-C-580	8115	..	DOD-Army-CE
Creosote, Technical Wood Preservative, (for) Brush Spray or Open Tank Treatment	Am. 1	.....	6810	..	GSA-FSS
Identification Marking of Aluminum Magnesium and Titanium	New	.....	..	..	DOD-Army-USAF
Lubricants, Liquid Fuels, and Related Products; Method of Testing	Rev.	Fed. Std. 791a	9150	..	DOD-Army-Ord.
Lumber and Timber, Hardwood	Rev.	MM-L-736	..	..	AGR-FS
Lumber and Timber, Softwood	Rev.	MM-L-00751e (AGR-FS)	5510	..	AGR-FS
Molding Plastic, Acrylic	Rev.	L-M-500	9330	..	DOD-Navy-Ships
Paint; Outside, Ready-Mixed Medium Chrome-Yellow	Rev.	TT-P-53b	8010	..	DOD-Army-CE
Paint; Ready-Mixed, Black	Rev.	TT-P-61c	8010	..	DOD-Army-CE
Paint; Ready-Mixed, Exterior-Chrome-Green	Rev.	TT-P-71c	8010	..	DOD-Army-CE
Paint; Ready Mixed, Exterior Medium Shades on a Lead Zinc Base	Rev.	TT-P-81d	8010	..	DOD-Army-CE
Paint; (Titanium-Lead-Zinc, and Oil, Exterior, Ready-Mixed, White and Light Tints)	Rev.	TT-P-102a	8010	..	DOD-Army-CE
Plastic Sheet, Scribe Coated	New	L-P-00517 (Navy-Ord)	9330	..	DOD-Navy-Ord.
Plastic Sheet, Tracing, Matte Finish	New	L-P-519a	9330	..	DOD-Navy-Ord.
Primer, Paint, Exterior (Undercoat for Wood, Ready Mixed, White and Tints)	Rev.	TT-P-25b	8010	52	DOD-Army-CE
Rope, Manila and Sisal	Am. 1	T-R-605	4020	40	DOD-Navy-Ships
Tape, Pressure-Sensitive Adhesive, Waterproof—For Packing and Sealing	Am. 3	PPP-T-60	8135	..	DOD-Navy-Aer
Tape: Rubber (Natural and Synthetic) Insulating	New	HH-T-00111d	..	..	COM-NBS
Xylene (for Use in Organic Coatings)	Rev.	TT-X-916b	6810P	..	GSA-FSS

TITLE CHANGES

Title	Type of Action	Symbol or Number	Former Title
Sulfuric Acid, Technical	Rev.	O-S-809a O-S-00809 (GSA-FSS)	Acid, Sulfuric; Technical-Grade

WITHDRAWALS

Title	Type of Action	Symbol or Number	Assigned Agency or Technical Committee	Reason for Withdrawal
Cloth, Cotton, Sheeting (Laundry Cover Cloth)	Am. 1	CCC-C-435	Army-QMC	Requested by QMC in order to investigate adequacy of current specification

PROMULGATIONS

Title	Type of Action	Symbol or Number
Acetic Acid, Glacial, Technical (superseding O-A-0076b(GSA-FSS) & O-A-76a)	Rev.	O-A-76c
Aluminum Alloy Plate and Sheet 5052 (superseding QQ-A-318b)	Rev.	QQ-A-318c
Aluminum Bronze, Rods, Shapes, Drawn Strip, and Forgings (superseding QQ-B-663)	New	QQ-A-630
Asphalt, Paving, Emulsion	Am. 1	SS-A-674b
Bags: Textile, Shipping, Burlap, Cotton, and Waterproof Laminated	Am. 1	PPP-B-35
Cloth, Cotton, Cheesecloth, Bleached and Unbleached (superseding CCC-C-271a)	New	CCC-C-440
Conservation of Automotive Engine Oils	New	Fed. Std. No. 103a
Creosote, Technical, Wood Preservative, (for) Brush, Spray, or Open-Tank Treatment	Am. 1	TT-C-655
Drums: Metal, 55-Gallon (for Shipment of Noncorrosive Material) (superseding PPP-D-00729a (COM-BDSA) & PPP-D-729	Rev.	PPP-D-729b
Methanol, Technical, (Methyl Alcohol) (superseding O-M-00232a(GSA-FSS) & O-M-232)	Rev.	O-M-232b
Molding Plastic, Poly(vinyl Chloride), Rigid (superseding L-M-00530 (Army-Ord) & L-V-345)	New	L-M-530a
Paperboard, Wrapping, Cushioning (superseding PPP-P-00291(COM-BDSA) & LLL-F-291)	New	PPP-P-291a
Sodium Borate, Decahydrate, Technical (Borax) (superseding SS-S-00535 (GSA-FSS) & SS-S-611a)	New	SS-S-535a
Thread, Linen	Am. 1	V-T-291b
Thread, Silk	Am. 1	V-T-301a
Tube, Flexible, Nonmetallic, Electrical (superseding HH-T-791a)	Rev.	HH-T-791b
Wire, Electrical, Steel, Copper-Covered (superseding QQ-W-421a)	New	QQ-W-345

INTERIM FEDERAL SPECIFICATIONS AND STANDARDS ISSUED

Title	Type of Action	Symbol or Number
Acoustical Units; Prefabricated	Am. 2	SS-A-118b (GSA-FSS)
Amyl Acetate (for Use in Organic Coatings)	New	TT-A-00511a (GSA-FSS)
Ethyl Alcohol (Ethanol); Denatured Alcohol; and Proprietary Solvent	Am. 1	O-E-760b (GSA-FSS)
Paint, 1200-Degree Heat-Resisting	New	TT-P-0028 (Navy-Ships)
Plastic Sheet, Tracing, Matte Finish	New	L-P-00519 (Navy-Ord.)
Tape, Gummed; Mending, and Reinforcing (Paper and Cloth)	New	UU-T-00101d (GSA-FSS)
Tape, Pressure-Sensitive Adhesive, Masking, Paper Varnish; Asphalt	New	UU-T-00106b (GSA-FSS)
Varnish; Asphalt	New	TT-V-0051b (GSA-FSS)
Xylene (for Use in Organic Coatings)	New	TT-X-0091a (GSA-FSS)

CANCELLATIONS

Title	Symbol or Number	Reason for Cancellation
Borax (Sodium Borate)	SS-B-611a	Superseded by Fed. Spec. SS-S-535a
Bronze, Aluminum; Rods, Bars, Shapes, and Forgings	QQ-B-663	Superseded by Fed. Spec. QQ-A-630
Cheesecloth, Bleached and Unbleached	CCC-C-271a	Superseded by Fed. Spec. CCC-C-440
Fiberboard; Corrugated, Single Face (Flexible)	LLL-F-291	Superseded by Fed Spec. PPP-P-291
Vinyl Chloride Polymer and Copolymer Rigid Molded Plastics	L-V-345	Superseded by Fed. Spec. L-M-530a

SPECIFICATIONS AND STANDARDS APPROVED FOR PRINTING

Title of Specification	Type of Action	Symbol or Number
Aluminum Alloy Bar, Rod, and Wire (Free-Machining), 2011	Rev.	QQ-A-365b
Aluminum Alloy Die Castings	Rev.	QQ-A-591b
Asphalt, Paving, Emulsion	Am. 1	SS-A-674b

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INDEX TO ADVERTISERS

Federal Government Standards Changes

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APPROVED FOR PRINTING

Calcium Chloride, Anhydrous, Technical Grade	Canc.	O-C-104
Calcium Chloride, Dihydrate and Calcium Chloride, Anhydrous; Technical	New	O-C-105a
Calcium-Chloride; Hydrated, Technical-Grade	Canc.	O-C-106a
Cheesecloth, Bleached and Unbleached	Canc.	CCC-C-271a
Cloth: Birdseye (Diaper), in Bolts	Canc.	CCC-C-411
Cloth, Cotton, Birdseye, and Gauze	New	CCC-C-425
Cloth, Cotton, Cheesecloth, Bleached and Unbleached	New	CCC-C-440
Cloth, Cotton, Duck, Bleached	New	CCC-C-442
Cloth, Jute (or Kenaf), Burlap	Am. 1	CCC-C-467
Creosote, Technical, Wood Preservative, (for) Brush, Spray, or Open-Tank Treatment	Am. 1	TT-C-655
Drums: Metal, 55-Gallon (for Shipment of Non-Corrosive Material)	Rev.	PPP-D-729b
Duck; Cotton, Bleached	Canc.	CCC-D-730
Fiberboard; Corrugated, Single Face, (Flexible)	Canc.	LLL-F-291
Gasoline, Automotive	New	VV-G-76
Gasoline, Automotive/Motor Fuel M	Canc.	VV-M-561a
Molding Plastic, Poly(vinyl Chloride), Rigid	New	L-M-530a
Plastic Compounds, Molding and Extrusion, Polyethylene	Am. 1	L-P-590
Plastic Sheet; Polystyrene, Modified	New	L-P-515
Sealing Compound; Cold-Application Mastic Multiple Component Type—for Joints in Concrete	Rev.	SS-S-159b
Sealing Compound; Cold-Application Ready-Mixed Liquefier Type, for Joints in Concrete	New	SS-S-158a
Solder: Lead Alloy, Tin Lead Alloy, and Tin Alloy; Flux Cored Ribbon and Wire, and Solid Form	Am. 1	QQ-S-571c
Tape, Pressure-Sensitive Adhesive, Identification (Acetate-Fiber)	New	L-T-99a
Thread, Linen	Am. 1	V-T-291b
Thread, Silk	Am. 1	V-T-301a
Tube, Flexible, Nonmetallic, Electrical	Rev.	HH-T-791b
Tube, Steel, Carbon, Mechanical, Round; Seamless and Welded	New	QQ-T-830
Vinyl Chloride Polymer and Copolymer Rigid Molded Plastics	Canc.	L-V-345
Wood Preservative: Osmosar (Osmosalts)	Am. 1	TT-W-569

OTS Reports

(*Continued from page 99*)

Determination of the Mechanical Properties of Aircraft-Structural Materials at Very High Temperatures After Rapid Heating. PB 131664, $3.

Effect of Prior Creep on Mechanical Properties of Aircraft Structural Metals: 2024-T86 Aluminum and 17-7 PH Stainless. PB 131716, $2.50.

Hydrogen in Titanium and Titanium Alloys. PB 121643, $2.50.

Report on Adhesive Bonding of Titanium. PB 121646, $1.

Manual on the Machining and Grinding of Titanium and Titanium Alloys. PB 121644, $2.

Metallurgical and Mechanical Characteristics of High-Purity Titanium-Base Alloys PB 131817, $2.75.

The Effect of Heat Treatment on the Stability and Creep resistance of a Ti-Al-Mo Alloy. PB 131673, 75 cents.

Machining Titanium: Part 2. PB 131536, $2.75.

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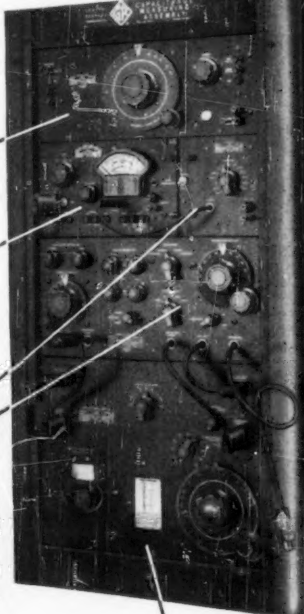

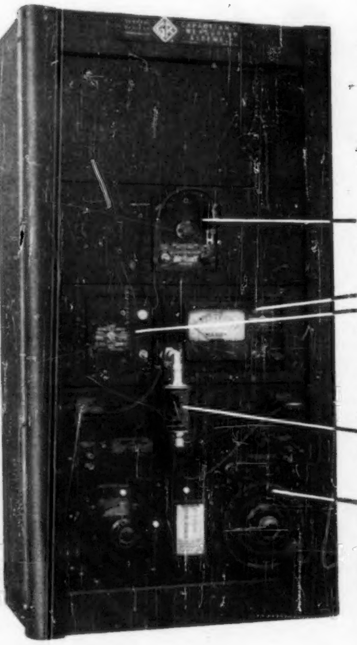

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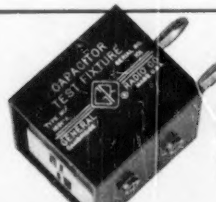

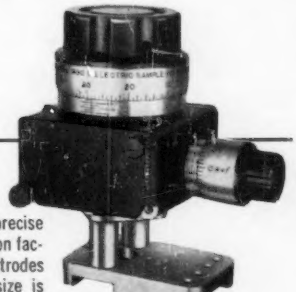

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